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A Fall Decathlon for Track Squads

By Frederick W. Cozens

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PURPOSE OF THE STUDY

In 1934 and 1935 the U.C.L.A. coaching staff ended its fall training program for track men by a decathlon competition. This decathlon had a very stimulating effect upon the squad, but it was felt that a point system for each event, of a nature similar to the Olympic decathlon, would give each performer a better chance to show his all-round ability, since, in these two years, only the ten high men in each event were able to score points. The purpose of this study then is two-fold, (1) to stimulate all-round competition among members of the fall track squad, and (2) to offer a scientific means of evaluating the efforts of individual squad members.

THE EVENTS FOR 1936 AND 1937

For the past two years the following events constituted the new decathlon:

(1) 75-yard dash
(2) 330-yard run
(3) 660-yard run
(4) 1320-yard run
(5) 120-yard low hurdles—(5 hurdles spaced 20 yards apart)
(6) Running high jump
(7) Running broad jump
(8) Standing hop, step, and jump
(9) 12-lb. shot-put
(10) Discus throw

It should be noted that running events do not cover standard distances, with the possible exception of the 75-yard dash, and that the pole vault is not included in the list of field events. The pole vault was purposely eliminated because of the danger involved to those individuals not familiar with the event, which includes the great majority of the fall squad members. After due consideration, the standing hop, step, and jump was agreed upon as a substitute for the pole vault.[1]

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[1] In administering the decathlon, three days should be allowed. The order of events on the three days will be as follows: (1) 75 yards, shot-put, standing hop, step, and jump, 330 yards; (2) 120-yd. low hurdles, running high jump, 660 yards; (3) running broad jump, discus throw, 1320 yards.

PRINCIPLES GOVERNING THE FORMULATION OF SCORING SCHEMES

In setting up a scoring scheme for any particular group, the following principles should be kept in mind:

1. The scoring scheme should be of the "increased increment" type because of the heterogeneous group involved. An increased increment scoring plan allows a larger number of points per given increase in performance as the performances improve from poor to good and then on to near world-record achievement. The group must be considered a heterogeneous one because of the fact that all types of men take part in each event, that is, jumpers put the shot and throw the discus, shot-putters and discus throwers jump and run, etc.

2. The scoring scheme should be usable throughout, that is, the 1,000-point level should be possible of attainment by an exceptional performer and the zero-point level should be low enough to include the performances of any men on the squad.

In other words, there should be no dead wood in the scoring scheme, no parts of the scale which are not used. Suppose an exceptional performer does score a thousand points, this simply means that he is nearing world's record attainment in that particular event.

3. Point values for each event must be computed in a scientific manner and must be based upon data actually collected in the field.

4. Any given point value should represent the same relative performance level in all events. This is not possible except by computations from data collected in the field on groups of men having abilities similar to those for whom the scoring scheme is devised.

THE DATA

The data for the scoring charts of the U.C.L.A. Fall Decathlon were collected (1) from the performance records of two previous decathlons, (2) from the results of five intramural track meets, and (3) from the performance records of men in track and field classes over a period of years. These data were then assembled into one distribution to form a composite picture of average ability in the various events. Obviously it would be unfair to score runners by a chart in the shot put devised only from the performances of specialists in that event. Likewise, it would be unfair to score jumpers by a chart in the discus throw computed solely from the performance records of discus throwers.

ANALYSIS OF PERFORMANCE VALUES

Table I shows in a comparative way a number of facts relating to all ten events. This table is necessary to determine whether or not the

values computed for the mean and standard deviation of each event represent comparable values.

In the running events, the distance in standard deviation value above mean performance for the world's record is approximately the same. For the field events, the standard deviation value of the world's record above mean performance is much higher than for the running events, but is again approximately the same for all events except the standing hop, step, and jump. The greater standard deviation value of the world's record for field events as against running events is undoubtedly due to the fact that the running performances are on the average somewhat higher than the field performances. The data collected for the standing hop, step, and jump represent only a small number of performances of athletes, untrained for that particular event, and hence standard deviation value from the mean to the world's record is greater than in any other event.

When a study of the best performance in each event as recorded at U.C.L.A. is made, the standard deviation values from the mean are all approximately the same. Likewise, the standard deviation values from the mean to the poorest performances are approximately the same. Thus it seems safe to assume that our mean performances throughout represent approximately equivalent values, at least for the University of California at Los Angeles.

A further analysis of the data for six events was made in order to show the relative performance levels as compared to scales already set up.[2] To make the comparisons consistent throughout, two particular groups, "Tall-Heavy" and "Medium-Medium," were used. These comparisons are shown in Table II and, while not entirely consistent, check up fairly well when all factors are considered, i.e., differences in standard deviation value, type of stature, experience in events, etc.

[2] F. W. Cozens, *Achievement Scales in Physical Education Activities for College Men.* (Philadelphia; Lea and Febiger, 1936.)

TABLE I

SHOWING EVENTS OF FALL DECATHLON IN RELATION TO VARIOUS STATISTICAL MEASURES

Event	World Records[1] 1934	Best Performance at U.C.L.A.	Mean	Standard Deviation	S.D.'s to World Record[2]	S.D.'s to Best U.C.L.A. Performances[3]	S.D.'s to Poorest Performance[4]
75-yard dash	7.4*s*	7.7*s*	9.6*s*	.527*s*	4.18	3.60	1.71
330-yard run	33.4*s*	35.1*s*	48.2*s*	3.54*s*	4.18	3.70	1.75
660-yard run	1*m* 19.0*s**	1*m* 22.0*s*	2*m* 00.0*s*	10.14*s*	4.04	3.75	1.77
1320-yard run	3*m* 00.6*s*	3*m* 14.0*s*	4*m* 20.2*s*	19.4*s*	4.10	3.41	1.75
120-yard low hurdles	12.5*s**	13.3*s*	16.9*s*	1.06*s*	4.15	3.40	1.70
12-pound shot	60′ 5½″	54′ 8″	38′ 6″	4.39′	5.00	3.68	1.71
Discus throw	171′ 11¾″	152′ 0″	94′ 0″	15.72′	4.96	3.69	1.75
Running broad jump	26′ 2⅜″	23′ 10″	17′ 1½″	20.6″	5.27	3.81	1.82
Running high jump	6′ 9⅛″	6′ 4″	4′ 10.6″	4.48″	5.03	3.88	1.70
Standing hop, step, and jump	34′ 8½″	30′ 9″	23′ 6.5″	22.6″	5.93	3.30	1.88

1 Taken from Spalding's Official *Athletic Almanac*, 1935.
2 The number of standard deviations from the mean to the world record.
3 The number of standard deviations from the mean to the best U.C.L.A. performance.
4 The number of standard deviations from the mean to the poorest performance in the fall decathlon.
*Approximated from nearly equivalent distances.

TABLE II

SHOWING EQUIVALENT SCORE VALUES IN SIX EVENTS FROM ACHIEVEMENT SCALES FOR COLLEGE MEN, USING TWO HEIGHT-WEIGHT GROUPS

Performance Level	120-yd. Low hurdles		12-lb. shot		Discus throw		Running broad jump		Running high jump		Standing hop, step, and jump	
	T.-H.[1]	M.-M.[2]	T.-H.	M.-M.	T.-H.	M.-M.	T.-H.	M.-M.	T.-H.	M.-M.	T.-H.	M.-M.
Mean of fall decathlon	53	51	66	85	61	78	63	62	59	60	64	65
Zero point fall decathlon	28	26	32	51	25	41	34	33	30	31	32	33
Best performance U.C.L.A.	101	99	137	157	139	155	127	127	124	125	137	138
1,000 points, fall decathlon	110	107	144	163	145	163	129	128	126	128	140	141
Score of 100 on achievement scales	13.4*s*	13.2*s*	46′1″	41′11″	123′0″	110′4″	21′0″	21′1″	5′9½″	5′9″	27′1″	27′0″

1 Tall-heavy.
2 Medium-medium.

METHOD OF PROCEDURE IN COMPUTING SCORING CHARTS

Following the line of argument set forth in the second principle governing the formulation of scoring schemes, it appears quite logical from the data of Table I that scoring may safely range from 1.75 standard deviations below the mean to 4 standard deviations above the mean. This range will accommodate both the poorest and the best performances with the exception of a very few poor performances in the standing hop, step, and jump, an event in which there is little practice by the fall track squad.

In using an "increased increment" type of scale with a range from -1.75σ to 4.0σ, it is necessary to follow a procedure described elsewhere.[3] The general equation will be $Y = KX^2$, where Y represents the point value at any particular performance level, K represents a constant depending upon the range and X represents the standard deviation value beginning with zero at 5σ below the mean.

In the particular problem at hand $X = 9$, being 4σ above the mean. Two other values must be obtained before point values can be computed, since scoring does not begin at 5σ below the mean but at 1.75σ below the mean. The general equation may then be put in the form $Y = KX^2 - S$, where S is a fixed sum to be subtracted from the value KX^2. At 4σ above the mean

$$1000 = K(9)^2 - S$$

while at 1.75σ below the mean

$$0 = K(3.25)^2 - S$$

Solving these two equations, $K = 14.2$ and $S = 150$.

To show the method of designating point values for any given performance, let us compute the point values for 49 ft. in the 12-lb. shot-put and 80 ft. in the discus throw.

SHOT PUT

Mean = 38.5 ft.
σ = 4.39 ft.
49 ft. = 10.5 ft. above the mean or 2.39σ above mean.

The X value for 49 ft. is the X value for the mean (5) plus 2.39 or 7.39. Therefore,

Point value for 49 ft. $= [(7.39)^2 \times 14.2] - 150 = 625$.

DISCUS THROW

Mean = 94.0 ft.
σ = 15.72 ft.
80 ft. = 14 ft. below the mean or $.891\sigma$ below mean.

The X value for 80 ft. is the X value for the mean (5) minus .891 or 4.109. Therefore,

Point value for 80 ft. $= [(4.109)^2 \times 14.2] - 150 = 90$.

[3] John F. Bovard and Frederick W. Cozens, *Tests and Measurements in Physical Education*. Rev. Ed. (Philadelphia: W. B. Saunders Company, 1938).

The following tables have been computed in a manner identical to that described above and it is hoped that this decathlon may prove interesting to coaches and track squads throughout the country. Though the data used in the construction of the tables were all secured at U.C.L.A., the tables may be used in a comparative way in any locality as they represent a cross-section of performances of normal college men.

As a matter of interest to coaches and competitors in other sections of the country, the performances of the U.C.L.A. winners in 1936 and 1937 are shown.

1936 COMPETITION

A two-day competition won by Robert Young, a middle distance runner and a member of the United States relay team at the 1936 Olympics.

Track Events	Performance	Points	*Field Events*	Performance	Points
75-yd. dash	7.8	855	Running high jump	5-9	611
120-yd. low hurdles	13.3	851	Running broad jump	22-1	734
330-yd. run	36.3	842	Standing hop, step, and jump	27-1	522
660-yd. run	1-27.1	815	12-lb. shot-put	36-3	136
1320-yd. run	3-54.5	418	Discus throw	94-3	207
Total		3781	Total		2210
Grand Total		5991			

1937 COMPETITION

A two-day competition won by Tom Berkeley, a low hurdler; fifth in 220-yd. low hurdles in the N.C.A.A. competition of 1937.

Track Events	Performance	Points	*Field Events*	Performance	Points
75-yd. dash	7.9	810	Running high jump	5-11	707
120-yd. low hurdles	12.9	942	Running broad jump	21-10	701
330-yd. run	35.6	890	Standing hop, step, and jump	25-9	391
660 yd. run	1-31.8	709	12-lb. shot-put	39-0	221
1320-yd. run	3-44.0	519	Discus throw	93-9	203
Total		3870	Total		2223
Grand Total		6093			

U.C.L.A.—FALL DECATHLON

330-YARD RUN; TIME IN SECONDS AND TENTHS

Time	Points	Time	Points	Time	Points	Time	Points
34.0	1003	39.1	664	44.2	383	49.3	162
34.1	995	39.2	658	44.3	378	49.4	158
34.2	988	39.3	652	44.4	373	49.5	155
34.3	981	39.4	646	44.5	369	49.6	151
34.4	974	39.5	640	44.6	364	49.7	147
34.5	967	39.6	634	44.7	359	49.8	143
34.6	960	39.7	628	44.8	354	49.9	140
34.7	953	39.8	622	44.9	349	50.0	136
34.8	946	39.9	616	45.0	345	50.1	133
34.9	939	40.0	610	45.1	340	50.2	129
35.0	932	40.1	604	45.2	335	50.3	126
35.1	925	40.2	598	45.3	330	50.4	123
35.2	918	40.3	592	45.4	326	50.5	119
35.3	911	40.4	586	45.5	321	50.6	116
35.4	904	40.5	581	45.6	317	50.7	112
35.5	897	40.6	575	45.7	312	50.8	109
35.6	890	40.7	569	45.8	308	50.9	105
35.7	883	40.8	564	45.9	303	51.0	102
35.8	876	40.9	558	46.0	299	51.1	98
35.9	869	41.0	552	46.1	294	51.2	95
36.0	862	41.1	547	46.2	289	51.3	92
36.1	855	41.2	541	46.3	285	51.4	88
36.2	848	41.3	536	46.4	280	51.5	85
36.3	842	41.4	531	46.5	276	51.6	81
36.4	835	41.5	525	46.6	271	51.7	78
36.5	829	41.6	519	46.7	267	51.8	75
36.6	822	41.7	514	46.8	263	51.9	72
36.7	815	41.8	508	46.9	259	52.0	69
36.8	809	41.9	503	47.0	255	52.1	65
36.9	802	42.0	497	47.1	250	52.2	62
37.0	796	42.1	491	47.2	246	52.3	59
37.1	789	42.2	486	47.3	242	52.4	56
37.2	783	42.3	481	47.4	238	52.5	53
37.3	776	42.4	476	47.5	234	52.6	50
37.4	770	42.5	470	47.6	229	52.7	47
37.5	764	42.6	465	47.7	225	52.8	44
37.6	757	42.7	460	47.8	221	52.9	41
37.7	751	42.8	454	47.9	217	53.0	39
37.8	745	42.9	449	48.0	213	53.1	36
37.9	738	43.0	444	48.1	209	53.2	33
38.0	732	43.1	438	48.2	205	53.3	30
38.1	725	43.2	433	48.3	201	53.4	27
38.2	719	43.3	428	48.4	197	53.5	24
38.3	713	43.4	423	48.5	193	53.6	21
38.4	707	43.5	418	48.6	189	53.7	18
38.5	701	43.6	413	48.7	185	53.8	15
38.6	694	43.7	408	48.8	181	53.9	12
38.7	688	43.8	403	48.9	177	54.0	10
38.8	682	43.9	398	49.0	173	54.1	7
38.9	676	44.0	393	49.1	169	54.2	4
39.0	670	44.1	388	49.2	165	54.3	2

U.C.L.A.—FALL DECATHLON

75-YARD DASH; TIME IN SECONDS AND TENTHS

Time	Points	Time	Points	Time	Points
7.5	995	8.5	563	9.5	233
7.6	948	8.6	525	9.6	205
7.7	901	8.7	488	9.7	179
7.8	855	8.8	453	9.8	153
7.9	810	8.9	418	9.9	129
8.0	767	9.0	385	10.0	105
8.1	724	9.1	352	10.1	83
8.2	682	9.2	321	10.2	62
8.3	642	9.3	290	10.3	41
8.4	602	9.4	261	10.4	21
				10.5	3

U.C.L.A.—FALL DECATHLON

660-YARD RUN; TIME IN SECONDS AND TENTHS

Time	Points	Time	Points	Time	Points	Time	Points
1-19.4	1001	1-34.5	651	1-49.5	367	2-04.5	144
1-20	986	1-35	641	1-50	359	2-05	138
1-20.5	973	1-35.5	630	1-50.5	350	2-05.5	132
1-21	960	1-36	620	1-51	342	2-06	126
1-21.5	948	1-36.5	610	1-51.5	334	2-06.5	120
1-22	936	1-37	600	1-52	326	2-07	114
1-22.5	924	1-37.5	590	1-52.5	318	2-07.5	108
1-23	911	1-38	580	1-53	310	2-08	102
1-23.5	899	1-38.5	570	1-53.5	302	2-08.5	96
1-24	887	1-39	560	1-54	294	2-09	90
1-24.5	875	1-39.5	550	1-54.5	286	2-09.5	84
1-25	864	1-40	540	1-55	278	2-10	79
1-25.5	852	1-40.5	530	1-55.5	270	2-10.5	73
1-26	841	1-41	521	1-56	263	2-11	67
1-26.5	829	1-41.5	512	1-56.5	256	2-11.5	62
1-27	817	1-42	502	1-57	248	2-12	56
1-27.5	806	1-42.5	493	1-57.5	241	2-12.5	51
1-28	794	1-43	483	1-58	233	2-13	46
1-28.5	783	1-43.5	474	1-58.5	226	2-13.5	41
1-29	772	1-44	465	1-59	219	2-14	36
1-29.5	761	1-44.5	455	1-59.5	212	2-14.5	31
1-30	750	1-45	446	2-00	205	2-15	26
1-30.5	738	1-45.5	437	2-00.5	198	2-15.5	21
1-31	727	1-46	428	2-01	191	2-16	16
1-31.5	716	1-46.5	419	2-01.5	184	2-16.5	11
1-32	705	1-47	410	2-02	177	2-17	7
1-32.5	694	1-47.5	401	2-02.5	171	2-17.6	1
1-33	683	1-48	392	2-03	164		
1-33.5	672	1-48.5	383	2-03.5	157		
1-34	662	1-49	375	2-04	150		

For performances located between times shown, compute point value in proportion to the increment for each half-second. Note that this increment changes according to the quality of the performance.

U.C.L.A.—FALL DECATHLON

1320-YARD RUN; TIME IN MINUTES AND SECONDS

Time	Points	Time	Points	Time	Points	Time	Points	Time	Points
3-03	995	3-25	724	3-47	489	4-09	292	4-31	130
3-04	981	3-26	712	3-48	480	4-10	283	4-32	123
3-05	968	3-27	701	3-49	470	4-11	275	4-33	117
3-06	955	3-28	689	3-50	460	4-12	267	4-34	110
3-07	942	3-29	678	3-51	451	4-13	259	4-35	104
3-08	929	3-30	667	3-52	441	4-14	251	4-36	98
3-09	917	3-31	656	3-53	432	4-15	244	4-37	92
3-10	904	3-32	645	3-54	423	4-16	236	4-38	86
3-11	891	3-33	634	3-55	413	4-17	228	4-39	80
3-12	879	3-34	623	3-56	404	4-18	221	4-40	74
3-13	866	3-35	612	3-57	395	4-19	213	4-41	68
3-14	854	3-36	602	3-58	386	4-20	206	4-42	63
3-15	842	3-37	591	3-59	377	4-21	199	4-43	58
3-16	830	3-38	581	4-00	368	4-22	192	4-44	53
3-17	818	3-39	571	4-01	359	4-23	185	4-45	47
3-18	806	3-40	560	4-02	350	4-24	178	4-46	42
3-19	794	3-41	550	4-03	342	4-25	171	4-47	36
3-20	782	3-42	540	4-04	333	4-26	164	4-48	31
3-21	771	3-43	529	4-05	325	4-27	157	4-49	25
3-22	759	3-44	519	4-06	317	4-28	150	4-50	20
3-23	747	3-45	509	4-07	308	4-29	143	4-51	15
3-24	736	3-46	499	4-08	300	4-30	137	4-52	10
								4-53	5
								4-54	1

For performances located between times shown, compute point value in proportion to the increment for each second. Note that this increment changes according to the quality of the performance.

U.C.L.A.—FALL DECATHLON

RUNNING HIGH JUMP; HEIGHT EACH QUARTER-INCH

Height	Points	Height	Points	Height	Points	Height	Points
6- 4½	999	5-10	658	5- 3½	377	4-9	156
6- 4¼	985	5- 9¾	646	5- 3¼	367	4-8¾	148
6- 4	971	5- 9½	634	5- 3	358	4-8½	141
6- 3¾	957	5- 9¼	622	5- 2¾	348	4-8¼	134
6- 3½	943	5- 9	611	5- 2½	339	4-8	127
6- 3¼	929	5- 8¾	599	5- 2¼	330	4-7¾	120
6- 3	915	5- 8½	588	5- 2	321	4-7½	113
6- 2¾	901	5- 8¼	577	5- 1¾	312	4-7¼	106
6- 2½	888	5- 8	566	5- 1½	303	4-7	100
6- 2¼	874	5- 7¾	555	5- 1¼	294	4-6¾	93
6- 2	861	5- 7½	544	5- 1	285	4-6½	87
6- 1¾	847	5- 7¼	533	5- 0¾	276	4-6¼	80
6- 1½	834	5- 7	522	5- 0½	268	4-6	74
6- 1¼	821	5- 6¾	511	5- 0¼	259	4-5¾	68
6- 1	808	5- 6½	500	5- 0	251	4-5½	62
6- 0¾	795	5- 6¼	489	4-11¾	242	4-5¼	56
6- 0½	782	5- 6	479	4-11½	234	4-5	50
6- 0¼	769	5- 5¾	468	4-11¼	226	4-4¾	44
6- 0	757	5- 5½	458	4-11	218	4-4½	38
5-11¾	744	5- 5¼	447	4-10¾	210	4-4¼	32
5-11½	732	5- 5	437	4-10½	202	4-4	27
5-11¼	719	5- 4¾	427	4-10¼	194	4-3¾	21
5-11	707	5- 4½	417	4-10	186	4-3½	16
5-10¾	694	5- 4¼	407	4- 9¾	178	4-3¼	10
5-10½	682	5- 4	397	4- 9½	171	4-3	5
5-10¼	670	5- 3¾	387	4- 9¼	163	4-2¾	1

U.C.L.A.—FALL DECATHLON

120-YARD LOW HURDLES; TIME IN SECONDS AND TENTHS

Time	Points	Time	Points	Time	Points	Time	Points
12.7	990	14.2	660	15.7	384	17.2	166
12.8	966	14.3	640	15.8	368	17.3	153
12.9	942	14.4	620	15.9	352	17.4	141
13.0	919	14.5	600	16.0	336	17.5	129
13.1	896	14.6	581	16.1	320	17.6	117
13.2	873	14.7	562	16.2	305	17.7	106
13.3	851	14.8	543	16.3	290	17.8	95
13.4	829	14.9	524	16.4	275	17.9	84
13.5	807	15.0	505	16.5	260	18.0	73
13.6	785	15.1	487	16.6	246	18.1	62
13.7	763	15.2	469	16.7	232	18.2	52
13.8	742	15.3	451	16.8	218	18.3	42
13.9	721	15.4	434	16.9	205	18.4	32
14.0	700	15.5	417	17.0	192	18.5	23
14.1	680	15.6	400	17.1	179	18.6	14
						18.7	5

U.C.L.A.—FALL DECATHLON

STANDING HOP, STEP, AND JUMP; DISTANCE IN FEET AND INCHES

Distance	Points	Distance	Points	Distance	Points	Distance	Points	Distance	Points
31- 0	990	28- 9	706	26- 6	463	24- 3	260	22- 0	98
30-11	978	28- 8	696	26- 5	455	24- 2	253	21-11	93
30-10	967	28- 7	686	26- 4	447	24- 1	246	21-10	88
30- 9	956	28- 6	677	26- 3	439	24- 0	240	21- 9	83
30- 8	945	28- 5	667	26- 2	431	23-11	233	21- 8	78
30- 7	934	28- 4	658	26- 1	423	23-10	227	21- 7	73
30- 6	923	28- 3	649	26- 0	415	23- 9	220	21- 6	68
30- 5	912	28- 2	639	25-11	407	23- 8	214	21- 5	63
30- 4	901	28- 1	630	25-10	399	23- 7	207	21- 4	58
30- 3	890	28- 0	621	25- 9	391	23- 6	201	21- 3	53
30- 2	879	27-11	611	25- 8	383	23- 5	195	21- 2	48
30- 1	868	27-10	602	25- 7	375	23- 4	189	21- 1	43
30- 0	858	27- 9	593	25- 6	368	23- 3	183	21- 0	39
29-11	847	27- 8	584	25- 5	360	23- 2	177	20-11	34
29-10	837	27- 7	575	25- 4	353	23- 1	171	20-10	30
29- 9	827	27- 6	566	25- 3	346	23- 0	165	20- 9	26
29- 8	816	27- 5	557	25- 2	338	22-11	160	20- 8	21
29- 7	806	27- 4	548	25- 1	331	22-10	154	20- 7	17
29- 6	796	27- 3	539	25- 0	324	22- 9	148	20- 6	13
29- 5	786	27- 2	531	24-11	316	22- 8	143	20- 5	8
29- 4	776	27- 1	522	24-10	309	22- 7	137	20- 4	4
29- 3	766	27- 0	514	24- 9	302	22- 6	131		
29- 2	756	26-11	505	24- 8	295	22- 5	126		
29- 1	746	26-10	497	24- 7	288	22- 4	120		
29- 0	736	26- 9	488	24- 6	281	22- 3	115		
28-11	726	26- 8	480	24- 5	274	22- 2	109		
28-10	716	26- 7	471	24- 4	267	22- 1	104		

For performances located between distances shown, compute point value in proportion to the increment for each inch.

U.C.L.A.—FALL DECATHLON

RUNNING BROAD JUMP; DISTANCE IN FEET AND INCHES

Distance	Points	Distance	Points	Distance	Points	Distance	Points	Distance	Points
24- 0	1001	22- 0	723	20- 0	483	18- 0	281	16- 0	118
23-11	988	21-11	712	19-11	474	17-11	273	15-11	112
23-10	976	21-10	701	19-10	465	17-10	266	15-10	106
23- 9	964	21- 9	691	19- 9	456	17- 9	258	15- 9	100
23- 8	952	21- 8	680	19- 8	447	17- 8	251	15- 8	94
23- 7	940	21- 7	670	19- 7	438	17- 7	243	15- 7	88
23- 6	928	21- 6	659	19- 6	429	17- 6	236	15- 6	83
23- 5	916	21- 5	649	19- 5	420	17- 5	229	15- 5	77
23- 4	904	21- 4	638	19- 4	411	17- 4	222	15- 4	72
23- 3	892	21- 3	628	19- 3	403	17- 3	215	15- 3	67
23- 2	880	21- 2	618	19- 2	394	17- 2	208	15- 2	61
23- 1	868	21- 1	608	19- 1	386	17- 1	201	15- 1	56
23- 0	857	21- 0	598	19- 0	377	17- 0	194	15- 0	51
22-11	845	20-11	588	18-11	368	16-11	187	14-11	46
22-10	834	20-10	578	18-10	360	16-10	181	14-10	41
22- 9	823	20- 9	568	18- 9	352	16- 9	174	14- 9	36
22- 8	811	20- 8	558	18- 8	344	16- 8	168	14- 8	31
22- 7	800	20- 7	549	18- 7	336	16- 7	161	14- 7	26
22- 6	789	20- 6	539	18- 6	328	16- 6	155	14- 6	21
22- 5	778	20- 5	530	18- 5	320	16- 5	148	14- 5	16
22- 4	767	20- 4	520	18- 4	312	16- 4	142	14- 4	11
22- 3	756	20- 3	511	18- 3	304	16- 3	136	14- 3	7
22- 2	745	20- 2	502	18- 2	296	16- 2	130	14- 2	3
22- 1	734	20- 1	492	18- 1	288	16- 1	124		

For performances located between distances shown, compute point value in proportion to the increment for each inch. Note that this increment changes according to the quality of the performance.

U.C.L.A.—FALL DECATHLON

DISCUS THROW; DISTANCE IN FEET

Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.
156-10	999										
156	986	141	757	126	553	111	375	96	223	81	98
155	970	140	743	125	541	110	364	95	214	80	90
154	954	139	729	124	528	109	353	94	205	79	82
153	938	138	715	123	516	108	343	93	196	78	75
152	922	137	701	122	504	107	332	92	187	77	68
151	906	136	687	121	491	106	322	91	178	76	61
150	891	135	673	120	479	105	311	90	170	75	54
149	875	134	659	119	467	104	301	89	161	74	47
148	860	133	646	118	455	103	291	88	153	73	41
147	845	132	632	117	443	102	281	87	145	72	34
146	830	131	619	116	431	101	271	86	136	71	28
145	815	130	605	115	420	100	261	85	128	70	21
144	801	129	592	114	408	99	251	84	120	69	15
143	786	128	579	113	397	98	242	83	113	68	9
142	772	127	566	112	386	97	233	82	105	67	3

For performances located between distances shown, compute point value in proportion to the increment for each foot.

U.C.L.A.—FALL DECATHLON

12-LB. SHOT-PUT; DISTANCE IN FEET AND INCHES

Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.	Distance	Pts.
56- 0	997	53- 5	852	50-10	716	48- 3	590	45- 8	475	43- 1	369	40- 6	272	37-11	186	35- 4	110	32- 9	43
55-11	992	53- 4	847	50- 9	712	48- 2	586	45- 7	471	43- 0	366	40- 5	269	37-10	183	35- 3	108	32- 8	41
55-10	987	53- 3	843	50- 8	708	48- 1	582	45- 6	468	42-11	362	40- 4	266	37- 9	180	35- 2	105	32- 7	39
55- 9	982	53- 2	838	50- 7	704	48- 0	579	45- 5	464	42-10	359	40- 3	263	37- 8	178	35- 1	103	32- 6	37
55- 8	977	53- 1	834	50- 6	700	47-11	575	45- 4	461	42- 9	356	40- 2	260	37- 7	175	35- 0	101	32- 5	35
55- 7	972	53- 0	829	50- 5	695	47-10	571	45- 3	457	42- 8	353	40- 1	257	37- 6	173	34-11	98	32- 4	33
55- 6	967	52-11	825	50- 4	691	47- 9	567	45- 2	454	42- 7	350	40- 0	255	37- 5	170	34-10	96	32- 3	31
55- 5	962	52-10	820	50- 3	687	47- 8	563	45- 1	450	42- 6	346	39-11	252	37- 4	168	34- 9	94	32- 2	29
55- 4	958	52- 9	816	50- 2	683	47- 7	559	45- 0	447	42- 5	343	39-10	249	37- 3	165	34- 8	92	32- 1	27
55- 3	953	52- 8	811	50- 1	679	47- 6	556	44-11	443	42- 4	340	39- 9	246	37- 2	163	34- 7	90	32- 0	26
55- 2	948	52- 7	807	50- 0	674	47- 5	552	44-10	440	42- 3	337	39- 8	243	37- 1	160	34- 6	88	31-11	24
55- 1	944	52- 6	802	49-11	670	47- 4	548	44- 9	436	42- 2	334	39- 7	240	37- 0	158	34- 5	85	31-10	22
55- 0	939	52- 5	798	49-10	666	47- 3	544	44- 8	433	42- 1	331	39- 6	238	36-11	155	34- 4	83	31- 9	20
54-11	934	52- 4	794	49- 9	662	47- 2	540	44- 7	429	42- 0	328	39- 5	235	36-10	153	34- 3	81	31- 8	18
54-10	929	52- 3	789	49- 8	658	47- 1	536	44- 6	426	41-11	325	39- 4	232	36- 9	150	34- 2	79	31- 7	16
54- 9	925	52- 2	785	49- 7	654	47- 0	533	44- 5	422	41-10	321	39- 3	229	36- 8	148	34- 1	77	31- 6	14
54- 8	920	52- 1	781	49- 6	650	46-11	529	44- 4	419	41- 9	318	39- 2	226	36- 7	146	34- 0	75	31- 5	12
54- 7	916	52- 0	776	49- 5	646	46-10	525	44- 3	415	41- 8	315	39- 1	224	36- 6	143	33-11	72	31- 4	10
54- 6	911	51-11	772	49- 4	642	46- 9	521	44- 2	412	41- 7	312	39- 0	221	36- 5	140	33-10	70	31- 3	9
54- 5	907	51-10	768	49- 3	638	46- 8	518	44- 1	408	41- 6	309	38-11	218	36- 4	138	33- 9	68	31- 2	7
54- 4	903	51- 9	764	49- 2	634	46- 7	514	44- 0	405	41- 5	306	38-10	215	36- 3	136	33- 8	66	31- 1	5
54- 3	898	51- 8	759	49- 1	630	46- 6	511	43-11	401	41- 4	303	38- 9	212	36- 2	133	33- 7	64	31- 0	4
54- 2	894	51- 7	755	49- 0	626	46- 5	507	43-10	398	41- 3	300	38- 8	210	36- 1	131	33- 6	62	30-11	2
54- 1	889	51- 6	751	48-11	622	46- 4	503	43- 9	395	41- 2	297	38- 7	207	36- 0	129	33- 5	59		
54- 0	884	51- 5	746	48-10	618	46- 3	499	43- 8	392	41- 1	294	38- 6	205	35-11	126	33- 4	57		
53-11	879	51- 4	742	48- 9	614	46- 2	496	43- 7	388	41- 0	291	38- 5	202	35-10	124	33- 3	55		
53-10	874	51- 3	738	48- 8	610	46- 1	492	43- 6	385	40-11	287	38- 4	199	35- 9	122	33- 2	53		
53- 9	870	51- 2	734	48- 7	606	46- 0	489	43- 5	381	40-10	284	38- 3	196	35- 8	120	33- 1	51		
53- 8	865	51- 1	729	48- 6	602	45-11	485	43- 4	378	40- 9	281	38- 2	194	35- 7	117	33- 0	49		
53- 7	861	51- 0	725	48- 5	598	45-10	482	43- 3	375	40- 8	278	38- 1	191	35- 6	115	32-11	47		
53- 6	856	50-11	721	48- 4	594	45- 9	478	43- 2	372	40- 7	275	38- 0	189	35- 5	112	32-10	45		

For performances located between distances shown, compute point value in proportion to the increment for each inch.

The Variations and Interrelations of the Last Lumbar Vertebra and Sacrum

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IN ANY field of teaching, it occasionally happens that a number of perplexing problems, when analyzed, appear to have a common element upon which the solution of each depends. One such element which is repeatedly encountered in those phases of physical education which deal with the analysis of movement and carriage is the lumbosacral relationship. This relationship is an exceedingly intricate one involving the transmission of relatively great weight through a small area with a shearing stress. The manner in which this transmission is accomplished is dependent upon the structure of the bones themselves, the length and tension of the ligaments which bind them, the muscular pulls involved, and the degree and character of the thrust upon the articulations. Because of the complexity of the mechanism, and as a first step in an attempt to throw more light on the problem, the present study was limited to a consideration of the bony variations and relations of the last lumbar vertebra and sacrum.

Most of the work which has been done on the lumbosacral articulations has dealt with one, or both, of two important aspects: the biological instability of the lower portion of the spine, and the mechanical stresses and strains to which it is subjected. This instability, which is regarded as a direct result of the shift from a quadrupedal to a bipedal base of support is evidenced by the frequency of structural variations. Two opposing tendencies are apparent: (1) a complete or incomplete liberation of the first sacral vertebra, and (2) a partial or complete inclusion of the last lumbar vertebra in the sacrum. Both types of change are frequently associated with anomalies and asymmetries at the lumbosacral junction.

Although no attempt was made in this study to analyze the causes of variations, it should be noted that they may be due to factors which are not of purely phylogenetic origin, e.g., congenital disturbances, disease, injury, pre- or post-natal malnutrition, disturbances in growth, and malalignment.

THE LUMBOSACRAL ARTICULATIONS

There are three lumbosacral articulations: two, between the inferior articular processes of the last lumbar vertebra and the superior articular

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processes of the sacrum, and the third, between the bodies of the two bones. This region is unstable mechanically as well as phylogenetically. The following facts are regarded by Von Lackum as responsible for its mechanical instability:

1. It is at the junction of the movable and relatively immovable portions of the spinal column.
2. The usual means of joint stabilization are at a disadvantage in consequence of a developmental structure designed for the quadrupedal position.
3. The strain at the joints is always shearing regardless of position.
4. There is rotatory action which is often asymmetrical.

The movements permitted between the articular surfaces are gliding movements as the body of the last lumbar vertebra moves on the intervertebral disc or vice versa. The degree of freedom of movement in the articulations is largely dependent upon the obliquity and symmetry of position of the articular surfaces which are located farther apart and are more powerful than are those on the vertebrae immediately above. If they are asymmetrical, movement is limited, blocked, or unusually free, depending upon the character of the asymmetry.

The stability of the articulations is dependent upon the lumbosacral angle as well as upon the position of the articular processes. The greater this angle, the greater is the weight that must be borne by the superior articulations of the sacrum and the less that borne by its more sturdy and larger surfaced body.

PURPOSE

The immediate object of the investigations described in this paper was threefold:

1. To examine the last lumbar vertebra and the sacrum of a series of modern white skeletons and to note their variations; to make pertinent measurements and descriptive classifications, where measurements were not feasible, of the inferior surface of the last lumbar vertebra and the superior surface of the sacrum.
2. To measure the lumbosacral angles of a somewhat comparable series of roentgenograms.
3. To consider the relations between the joint surfaces made evident by an examination of the resulting data.

PROCEDURE

The bones used in this study were made available at the Hamann Museum of Western Reserve University. They consisted of two series of skeletons with an age range of from twenty to fifty years. The first

was a series of 79 male white skeletons; the second, a series of 78 female white skeletons. Although an effort was made to secure fair samples of material, it should be borne in mind, when considering these data, that they are based upon measurements and descriptive observations made upon the bones of people who were the unfortunates of a great city. The age range was chosen as one which would include adult skeletons, the bones of which would not show extreme age changes.

The lumbosacral angles were measured on a series of 76 roentgenograms.[1] Each was a lateral lower abdominal and pelvic view taken with the subject lying on the right side. All subjects were male laborers whose age was unknown. These roentgenograms were not made for the purpose of affording an opportunity for the measurement of the lumbosacral

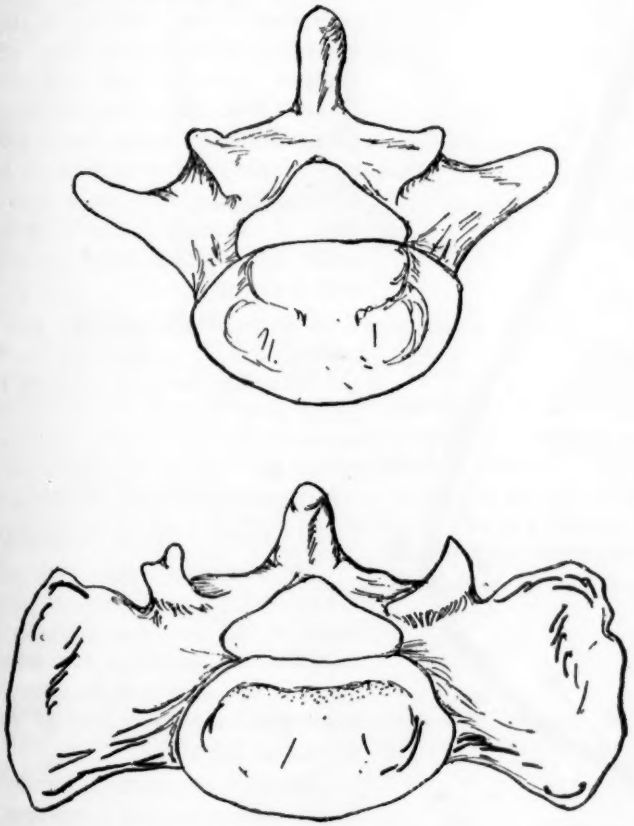

FIGURE 1. Camera lucida drawing of the inferior surface of the last lumbar vertebra and the superior surface of the sacrum of skeleton 1298.

[1] Here the term lumbosacral angle refers to the angle formed by the inferior surface of the last lumbar vertebra and the superior surface of the sacrum.

angle. Therefore they were not centered on the last intervertebral disc. They were, however, centered near the middle of the body of the fourth lumbar vertebra, so that, although the angles were distorted, these measurements should be fairly equally proportional to the actual measurements of the angles.

The first step in the accumulation of data consisted in making one to two camera lucida drawings of the inferior surface of the last lumbar vertebra and the superior surface of the sacrum (Fig. 1).

FIGURE 2. The measurement of the sacral curve.

The longitudinal curve of the inner surface of the sacrum was obtained by the use of a lead wire which was pressed firmly into the curve at the center of the bone throughout its length. The wire presented a true picture of the curve which could be traced (Fig. 2). The angle of curvature was then measured. From a line, *AC*, drawn to connect the two extremities of the curve a perpendicular, *DB*, was erected to the apex of the curvature. Lines were then drawn from *B* through *A* and *C* giving the angle *ABC* which could be measured with a protractor.

Using a sliding caliper which was calibrated with a standard instrument, the following measurements of the inferior body surface of the last lumbar vertebra and the superior body surface of the first sacral segment were made:

a) Greatest anteroposterior diameter.

b) Greatest transverse diameter.

These measurements were taken to the nearest 0.1 millimeter, although, because of the irregular character of the material, the precision was 0.25 millimeter. They were used to determine relative diameter variations of the two surfaces (Table II).

Although quantitative measurements of the obliquities and curvatures of the articular surfaces might be of interest, the difficulties of making them with any degree of precision ruled them out. Instead, because of their relative value, descriptive classifications were used.

The data concerning the posterior margins of the body surfaces of the two bones were used together, as were the diameter measurements, to show the frequency of the combinations of these variations (Tables II and V).

Numerical variations in the segments of the two regions and other anomalies were noted.

The lumbosacral angle was measured from tracings of the roentgenograms. The lines *FG* and *GH*, extended to the point of intersection, were then drawn along the inferior surface of the body of the last lumbar vertebra and the superior surface of the body of the sacrum (Fig. 3). The angle *FGH* represents the angle made by the adjoining surfaces. It was measured with a protractor to the nearest 0.5 degree with a precision of 0.5 degree (Table VIII).

FIGURE 3. Measurement of the lumbosacral angle.

RESULTS

In discussing these results and their significance, an effort has been made to avoid their direct application until further checking on cadavers, roentgenograms, and living human beings is possible.

The data showing the degree of sacral curvature are given in Table I. The angle range for the male curves was 95 to 155 degrees with a median of 124 degrees; for the female curves 105 to 155 degrees with a median of 126 degrees; and for the combined series 95 to 155 degrees with a median of 125 degrees.

TABLE I

THE SACRAL CURVE*

Degrees	95–104	105–114	115–124	125–134	135–144	145–154
Male No.	2	17	22	19	11	7
Per cent	3	22	28	24	14	9
Female No.	0	6	10	10	10	2
Per cent	0	16	26	26	26	6
Total No.	2	23	32	29	21	9
Per cent	2	20	28	25	18	7

*Only 38 of the female skeletons were used in this tabulation.

The sacra showed considerable variation, not only in the degree of curvature but in contour. The apex was located on the second segment in 7 per cent, on the third in 81 per cent, and on the fourth in 12 per cent of the cases. Considered separately the two series showed the same general trends with a somewhat greater tendency toward a low apex among the female curves. The figures for the separate series are:

Apex	Second segment	Third segment	Fourth segment
Male	8 per cent	84 per cent	8 per cent
Female	5 per cent	75 per cent	21 per cent
Total	7 per cent	81 per cent	12 per cent

The variations of the body diameters are indicated in Table II. In 78 per cent of the articulations examined the anteroposterior diameters

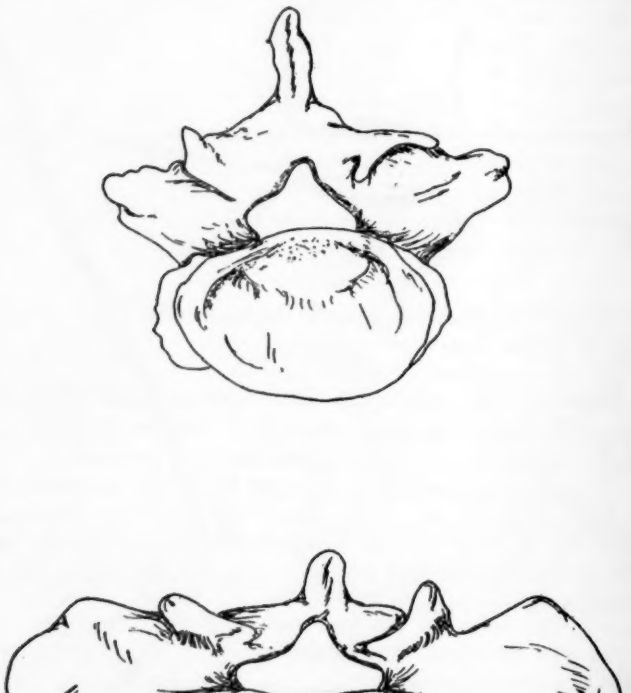

FIGURE 4. Inferior surface of the last lumbar vertebra and superior surface of the sacrum of skeleton 603. Note the difference in diameter as well as the variations in the posterior body margins.

of the lower surface of the last lumbar vertebrae were greater than those of the sacra (Fig. 4), in 12 per cent of the cases they were equal, in 10 per cent of the cases they were less. The variations of the transverse diameter relations were more evenly distributed. In 52 per cent of the cases the transverse diameter of the lower surface of the last lumbar vertebra was less than that of the sacrum, in 10 per cent of the cases it was equal, and in 38 per cent of the cases it was less. These differences ranged from 0.5 millimeter to 6.5 millimeters.

TABLE II

DIAMETER VARIATIONS OF THE BODY SURFACES OF THE LUMBOSACRAL ARTICULATION

	Anteroposterior Diameter			Transverse Diameter		
	Lumbar > Sacral	Lumbar < Sacral	Equal	Lumbar > Sacral	Lumbar < Sacral	Equal
Male No.	56	8	15	21	51	7
Per cent	71	10	19	27	65	8
Female No.	66	8	4	39	30	9
Per cent	85	10	5	50	39	11
Total No.	122	16	19	60	81	16
Per cent	78	10	12	38	52	10

An effort was made to see in what combinations these variations occurred with the following results:

1. Both diameters of the last lumbar vertebra greater than those of the sacrum

44 per cent male, 33 per cent female, 39 per cent total

2. Anteroposterior diameter of the last lumbar vertebra greater than that of the sacrum, and the transverse diameter less than that of the sacrum

16 per cent male, 41 per cent female, 29 per cent total

3. Both diameters of the last lumbar vertebra less than those of the sacrum

5 per cent male, 4 per cent female, 4 per cent total

4. Transverse diameter of the last lumbar vertebra greater than that of the sacrum and the anteroposterior diameter less than that of the sacrum

3 per cent male, 5 per cent female, 4 per cent total

5. Both diameters of both bones equal

32 per cent male, 17 per cent female, 24 per cent total

The outstanding fact, made clear by these results, was the high frequency with which the anteroposterior diameter of the last lumbar vertebra exceeded that of the sacrum. In the cases where this occurred the explanation for the difference lay largely in the variation in curvature of the posterior margins. Willis measured these diameters on 50 skeletons

and found that 66 per cent of them had unequal anteroposterior diameters. This difference he considered of importance in diagnosing displacements from roentgenograms.

The mechanical significance of this slight difference, 0.5 millimeter to 6.5 millimeters is questionable but it may deserve further consideration.

Certain outstanding characteristics of the articular processes of the last lumbar vertebra are indicated in Table III. They varied in vertical obliquity from facing forward to facing laterally. The largest group, 43 per cent, faced in an intermediate direction, while 6 per cent were grossly asymmetrical.

The horizontal obliquity varied from a slightly downward to a markedly downward facing. The largest group, 48 per cent, faced slightly downward. This group was followed closely by a group of 47 per cent which faced moderately downward. Gross asymmetries of the two sides were noted in 1 per cent of the cases.

The articular surfaces were concave in 62 per cent of the cases,

TABLE III

LAST LUMBAR VERTEBRA—INFERIOR ARTICULAR SURFACES

	Vertical Obliquity			
	Intermediate	Forward > Lateral	Forward < Lateral	Gross Asymmetry
Male No.	35	25	17	2
Per cent	44	32	22	2
Female No.	32	28	10	8
Per cent	41	36	13	10
Total No.	67	53	27	10
Per cent	43	34	17	6

	Horizontal Obliquity			
	Slight	Moderate	Marked	Gross Asymmetry
Male No.	34	41	4	0
Per cent	43	52	5	0
Female No.	41	33	3	1
Per cent	53	42	4	1
Total No.	75	74	7	1
Per cent	48	47	4	1

	Articular Surfaces				
	Concavo-convex	Concave	Convex	Gross Asymmetry	Flat
Male No.	13	59	0	7	0
Per cent	16	75	0	9	0
Female No.	27	38	0	11	2
Per cent	35	49	0	14	2
Total No.	40	97	0	18	2
Per cent	26	62	0	11	1

concavo-convex in 26 per cent, grossly asymmetrical in 11 per cent, and flat in 1 per cent. None of these surfaces were convex.

The vertical obliquities of the articular processes of the sacra varied from facing backward to facing medially. Here, as was the case with the last lumbar vertebrae, the highest percentage, 50, faced in an intermediate direction, while the percentage of gross asymmetries, 17, was considerably greater.

The horizontal obliquity ranged from slightly upward to markedly upward. The highest percentage, 71, faced moderately upward. Gross asymmetries were found in 3 per cent of the cases.

Here, as in the case of the inferior articular surfaces of the last lumbar vertebrae, the greatest percentage, in this case 77, were concave, 1 per cent were concavo-convex, 1 per cent grossly asymmetrical, 10 per cent were flat, 1 per cent convex.

TABLE IV

SACRUM—SUPERIOR ARTICULAR SURFACES

	Vertical Obliquity			
	Intermediate	Backward > Medial	Backward < Medial	Gross Asymmetry
Male No.	39	22	10	8
Per cent	49	28	13	10
Female No.	39	16	4	19
Per cent	50	21	5	24
Total No.	78	38	14	27
Per cent	50	24	9	17

	Horizontal Obliquity			
	Slight	Moderate	Marked	Gross Asymmetry
Male No.	22	53	4	0
Per cent	28	67	5	0
Female No.	8	59	7	4
Per cent	10	76	9	5
Total No.	30	112	11	4
Per cent	19	71	7	3

	Articular Surfaces				
	Concavo-convex	Concave	Convex	Gross Asymmetry	Flat
Male No.	0	60	0	9	10
Per cent	0	76	0	11	13
Female No.	2	62	1	8	5
Per cent	3	80	1	10	6
Total No.	2	122	1	17	15
Per cent	1	77	1	11	10

The articular surfaces showed a considerable range of obliquity in both the horizontal and vertical planes. The high percentage of fre-

quency of the different classes for each obliquity leads to the assurance that there is no typical obliquity of the articular surfaces of this region. Gross right and left asymmetries occurred in 7 per cent of the skeletons examined. The investigations of Brailsford of the roentgenograms of 3,000 patients gave the following figures regarding the articular surfaces of the sacrum: "57 per cent face backward, 12 per cent inwards, and 30 per cent are mixed—that is, one may face backward and the other inwards, one may be vertical, the other oblique."

The stability of the last lumbar vertebra upon the sacrum is largely dependent upon the direction and the curvature of these surfaces. The least stable joints are those in which mutually flattened surfaces face forward-backward, and nearly horizontally, while the most stable joints are those in which mutually curved surfaces face moderately inward-outward and somewhat vertically.

In summarizing the data regarding the articular surfaces it should be noted that on both bones the surfaces are concave in a large number of cases, that the variation in obliquity is such that no class may be regarded as typical, and that the mechanical stability at the lumbo-sacral junction depends in a large measure upon these articulations.

The posterior margins of the body surfaces are of interest when considered together. Their relations are shown in Table V. In three of the classes, the total percentage of which is 45, the lumbar margin was convex or straight, and thus would tend to overhang the corresponding concave or straight margin of the sacrum below it.

TABLE V

COMBINATIONS OF POSTERIOR BODY MARGINS

	Lumbar Sacral concave	Lumbar Sacral convex	Lumbar Sacral straight	Lumbar concave Sacral convex	Lumbar concave Sacral straight
Male No.	15	17	1	3	5
Per cent	19	22	1	4	6
Female No.	19	15	1	3	6
Per cent	24	19	1	4	8
Total No.	34	32	2	6	11
Per cent	22	20	1	4	7

	Lumbar convex Sacral concave	Lumbar convex Sacral straight	Lumbar straight Sacral concave	Lumbar straight Sacral convex
Male No.	22	14	1	1
Per cent	28	18	1	1
Female No.	27	6	1	0
Per cent	35	8	1	0
Total No.	49	20	2	1
Per cent	31	13	1	1

In addition, attention is called to the following figures derived from the same table:

	Margin convex	Margin concave	Margin straight
Lumbar vertebra	64 per cent	33 per cent	3 per cent
Sacrum	25 per cent	54 per cent	21 per cent

They indicate a predominance of convexity of the lumbar margin, and of concavity of the sacral margin.

A further general observation was made that the posterior portion of the inferior surface of the last lumbar vertebra was convex, or somewhat cushioned, in 73 per cent of the cases while the superior surface of the sacrum was nearly flat or slightly concave in the entire group. The significance of the variations of the posterior margins has already been referred to in the discussion of the diameters of the surfaces. The possible significance of the tendency of the cushioned posterior margin of the last lumbar vertebra to overhang the flat or somewhat hollowed concave margin of the sacrum, invites speculation as to the mechanics of this region. This is an especial temptation in view of the obliquity of the thrust of the upper bone and the possible effect upon the stability of the joint between the two bodies.

The anomalies of the last lumbar vertebrae are classified in Table VI. They varied from delayed bony union, which was not recorded because of the uncertainty of recognition, to such gross anomalies as impingement of the transverse process upon the sacrum—here for

TABLE VI

ANOMALIES OF THE LAST LUMBAR VERTEBRA

	Neural Canal					
	Synchondrosis		Non-union laminae			
	Spine	Laminae	Posterior	Unilateral	Bilateral	Rudimentary
Male No.	0	0	2	2	3	0
Per cent	0	0	3	3	4	0
Female No.	2	1	0	0	0	1
Per cent	3	1	0	0	0	1
Total No.	2	1	2	2	3	1
Per cent	1	1	1	1	2	1

	Separate neural arch		Pseudoarticulation		Number of Segments		
	Unilateral	Bilateral	Unilateral	Bilateral	4	5	6
Male No.	1	3	3	1	2	74	3
Per cent	1	4	4	1	2	94	4
Female No.	0	0	1	1	1	76	1
Per cent	0	0	1	1	1	98	1
Total No.	1	3	4	2	3	150	4
Per cent	1	2	3	1	2	96	2

brevity, and because of the lack of a better term, referred to as a pseudoarticulation—complete separation of the neural arch and non-development of the laminae. Often more than one anomaly occurred in the same vertebra. In these cases there was frequently considerable distortion.

Anomalies were shown in 20 per cent of the males and 7 per cent of the females. The total percentage equaled 14. Numerical segmental variation from the usual number of five occurred in 4 per cent of the total number of cases, of which 2 per cent had four segments and 2 per cent six segments.

The anomalies of the sacra were similar in character to those of the last lumbar vertebrae. They are classified in Table VII. An occasional case was found in which the sacrum and ilium were ankylosed on one or both sides. This occurred in 2 per cent of the skeletons examined.

Anomalies were shown in 28 per cent of the males, 16 per cent of the females, and 22 per cent of the two series taken as a whole. The most common anomaly was the non-union of the neural canal of the first segment. Segmental variation in number from the usually accepted five occurred in 27 per cent of the cases and was always an increase to six rather than a decrease.

TABLE VII

ANOMALIES OF THE SACRUM

	Synchondrosis		Neural Canal				
	1st segment						
	Spinous process	Transverse process	1st segment	2nd segment	3rd segment	4th segment	complete
Male No.	0	0	13	0	2	1	2
Per cent	0	0	17	0	3	1	3
Female No.	1	3	5	2	0	0	1
Per cent	1	4	6	3	0	0	1
Total No.	1	3	18	2	2	1	3
Per cent	1	2	12	1	1	1	2

	Ankylosis with ilium		Number of Segments		
	Unilateral	Bilateral	4	5	6
Male No.	2	1	0	48	31
Per cent	3	1	0	61	39
Female No.	0	1	0	66	12
Per cent	0	1	0	85	15
Total No.	2	2	0	114	43
Per cent	1	1	0	73	27

The instability of the last lumbar vertebra and sacrum has been widely recognized and many studies have been made of the resulting anomalies. Brailsford, working with the roentgenograms of 3,000 patients, found that defects of the neural arch of the last lumbar vertebra occurred in 6 per cent of the cases (10 per cent in the present study) and of the first and second sacral segments in 11 per cent of the cases (14 per cent in the present study).

Willis, in examining 748 spines, found that there was a separate neural arch in 4 per cent of the cases (2 per cent in the present study). He also found that the numerical stability of the entire column of these spines was 96 per cent, a figure with which the present numerical calculations tend to agree, indicating that the variations in segmentation occur most often in the lower portion of the spine.

Ankylosis of the sacrum with the ilium was noted in 1 per cent of the cases. Such anomalies, especially those involving partial or complete separation of the neural arch, asymmetries and ankylosis of any sort, are important mechanical factors in that they may greatly increase or decrease the amount of movement permitted in the affected area. Frequently the mechanics of the articulations are complicated by the presence of multiple anomalies.

As has been previously indicated, the data relating to the lumbosacral angle are based upon male material unselected as to age. The range was from 5 to 35 degrees, with a median of 16 degrees.

TABLE VIII

THE LUMBOSACRAL ANGLE

Degrees	5–9	10–14	15–19	20–24	25–29	30–34
Male No.	5	21	33	11	4	2
Per cent	7	28	43	14	5	3

In the literature which has been written on the subject the term, lumbosacral angle, has meant both the angle formed by the inferior surface of the body of the last lumbar vertebra and the superior surface of the sacrum, and the angle which is made by the anterior surfaces of the two bones. Furthermore, the measurements have been made by so many different methods that the numerical results are not readily comparable. The large text-books of anatomy have not defined the angle nor have they indicated, even when they have given figures, how they have been obtained. It would be interesting to follow this further by studying roentgenograms taken under carefully controlled conditions with individuals in the standing position, and also to study a comparable series of female roentgenograms.

CONCLUSIONS

In an effort to seek fundamentals in the problems of the mechanics of the lower back an examination was made of the last lumbar vertebra and sacrum of 157 skeletons in order to determine the type and frequency of anomaly and numerical variation. In addition, measurements and descriptive classifications of the articular surfaces were made in order to determine the character and frequency of variation. Finally, the lumbosacral angles of a series of 76 male roentgenograms were measured in order to determine the size and variability of the angles.

From the resulting data the following facts were evident:

1. The sacral curvature varied widely in degree of angulation and contour. The apex of the curve was located on the third segment in 81 per cent of the cases. In instances where it was not located on the third segment, the female specimens showed a greater tendency toward a low apex than did the male specimens.

2. The relations between the adjoining body surfaces were such as to indicate that the last lumbar vertebra overhung the sacrum posteriorly from 0.5 millimeter to 6.5 millimeters in 78 per cent of the cases. That this was so, was largely due to the relations of the curvatures of the posterior margins.

The mechanical importance of this, coupled with the fact that the posterior portion of the inferior surface of the last lumbar vertebra tends to be cushioned and presses upon the flat or hollowed sacral surface with an oblique thrust, is probably significant.

3. The articular processes of the junction varied to such an extent that no single accurate characterization could be made of their obliquities save that of variability. The articular surfaces of the lumbar vertebrae were concave in 62 per cent and of the sacrum in 77 per cent of the cases.

4. Anomalies involving the neural arch and evidence of pseudo-articulation of the transverse process of the last lumbar vertebra with the sacrum occurred in 14 per cent of the spines examined. The percentage of similar anomalies of the sacra was 22. These anomalies are generally conceded to be one indication of the instability of the lower portion of the spine. They are often of great importance to the mechanics of the region in that they are factors which increase or limit motion.

5. Because of the material used the results of the measurement of the lumbosacral angles were not in themselves significant beyond outlining a range and pointing toward a median. They do, however, suggest infinite possibilities of further study for those interested in the mechanics of the body and its movement.

LITERATURE CITED

Anderson, R. J., "Observation on the Diameters of Human Vertebrae in Different Regions," *J. Anat. and Physiol.* 17 (1883), 341–344.

Baur, G., "On Intercalation of Vertebrae," *J. Morph.* 4 (1891), 331–336.

Brailsford, J. F., "Deformities of the Lumbosacral Region of the Spine," *Brit. J. Surg.* 16 (1929), 562–627.

Cunningham, D. J., "The Lumbar Curve in Man and the Apes," *Royal Irish Acad. Cunningham Mem.* II (1886), 1–148.

—— "The Significance of Anatomical Variations," *J. Anat. and Physiol.* 33 (1898), 1–9.

Cyriax, E. F., "On Certain Absolute and Relative Measurements of Human Vertebrae," *J. Anat.* 54 (1920), 305–308.

Danforth, C. H., "Numerical Variation and Homologies in Vertebrae," *Am. J. Phys. Anthrop.* 14 (1930), 463–481.

Dwight, T., "Description of the Human Spines Showing Numerical Variation in the Warren Museum of the Harvard Medical School," *Anat. Anz.*, Bd. 19 (1901), S. 321–332 and 337–347.

—— "Numerical Variation in the Human Spine with a Statement Concerning Priority," *Anat. Anz.*, Bd. 28 (1906), S 33–40 and 96–102.

Goldthwait, J. E., L. T. Brown and L. T. Swain, *Body Mechanics* (Philadelphia: J. B. Lippincott, 1934).

Mitchell, G. A. G., "The Lumbosacral Junction," *J. Bone and Joint Surg.* 32 (1934), 233–254.

Rosenberg, E. W., "Contribution to the Knowledge of the Development of the Vertebral Column of Man," *Proc. Sect. Sc. Akad. Wet. Amsterdam* 15 (1912), 80–96.

Steindler, A., *Diseases and Deformities of the Spine and Thorax* (St. Louis: C. V. Mosby Co., 1929).

Todd, T. W., "Numerical Significance in the Thoracicolumbar Vertebrae of the Mammalia," *Anat. Rec.* 24 (1922), 260–284.

Todd, T. W. and S. I. Pyle, "Effects of Maceration and Drying Upon the Vertebral Column," *Am. J. Phys. Anthrop.* 12 (1928), 303–319.

—— "A Quantitative Study of the Vertebral Column by Direct and Roentgenoscopic Methods," *Am. J. Phys. Anthrop.* 12 (1928), 321–337.

Trotter, M., "The Sacrum and Sex," *Am. J. Phys. Anthrop.* 9 (1926), 445–450.

Turner, W., "The Lumbar Curve of the Spinal Column in Several Races of Men," *J. Anat. and Physiol.* 20 (1886), 536–543.

Von Lackum, H. L., "The Lumbosacral Region: An Anatomic Study of Some Clinical Observations," *J. A. M. A.* 82 (1924), 1109–1114.

Willis, T. A., "Backache—An Anatomical Consideration," *J. Bone and Joint Surg.* 14 (1932), 267–272.

—— "Backward Displacement of the Fifth Lumbar Vertebra: An Optical Illusion," *J. Bone and Joint Surg.* 17 (1935), 347–352.

Experiments in Health Education at the College Level

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THE PROBLEM

THE elementary and secondary schools have a real responsibility for health education, but does the college or university? If we believe that the people attending these higher institutions have greater social responsibilities proportional to their additional educational opportunities the answer must be yes. The individuals benefiting most from our educational resources should be the ones contributing most to elevating social welfare in general, which necessarily includes individual and community health. Because this philosophy does not work too well in practice is no reason to alter it. Rather we should be continually seeking the reasons for its poor functioning with a view to improving the chances for its operation.

The need for supplementing the health education received in elementary and secondary schools for college students is sensed more acutely when an appraisal is made of the knowledge concerning health which students have upon entering college. Such an appraisal made on all students entering Antioch College during the last three years has revealed a decided prevalence of misconceptions, ignorance, and superstitious beliefs. These students have come from 37 of the 48 states, and may be considered to reflect, somewhat, the degree and type of health education received in elementary and secondary schools in the country at large. The reflection seems indicative of a need for better teaching both on the lower and higher educational levels.

To get some idea of what the college or university has to do in health education and to find out how to do the job in the best way has been the object of the study being carried on at Antioch College, part of which is reported here.

What may be considered the minimum essential health knowledge of which a college student could reasonably be expected to have some mastery?—An ideal method of arriving at a basic outline of minimum essentials would be for a group composed of experts (physicians and hygienists), educators, and students to attempt to analyze health knowledge needs in terms of the functions which such knowledge would be expected to serve in life situations both during and after college. In preparing such an outline for the Antioch study a modification of this procedure

was used, but it is hoped in future work to utilize the above approach. In this study, one person set up what were conceived to be the functional needs of the average college trained individual in our society and then outlined the educational content considered necessary to fulfill those needs.[1] This outline, after submission to some physicians, hygienists, and educators for critical appraisal, was developed into a form to serve as the basis for the diagnostic and achievement tests discussed in this paper.

Diagnostic testing.—With the outline of objectives in terms of the minimum essentials of health knowledge developed, the next step was the preparation of a test purporting to be diagnostic in nature to be used as a measure of what knowledge students would exhibit in the areas covered by the outline. Where a college student body is drawn from a multiplicity of schools having various standards, and where differing environmental backgrounds have produced a diversity of attitudes regarding many phases of life, it seems essential that some knowledge of the individual differences between students be obtained. The more we know of the types of pictures or images in students' minds; the kinds of experiences, slogans, and stories which provide the foundation for their beliefs and which act as the mainsprings of their behavior, the better we can adapt the teaching procedure toward modifying behavior. The less we know of such matters the more blind are our teaching efforts, and the more lifeless our presentation of subject matter is apt to be.

The use of diagnostic tests is *one* method of getting some conception of these beliefs, and of the knowledge upon which a student's health behavior is predicated. The results of a good diagnostic health test given to students entering college should be valuable in several ways in organizing health education. Such a test should furnish something of a composite picture of the beliefs and knowledge underlying the behavior of the group. This information when matched with the basic outline of health knowledge desired not only shows the areas in that outline which are going to need specific emphasis for all students, but very frequently also indicates the *type* of emphasis or teaching presentation that is going to be needed, if successful results are to be obtained.

Self-motivation and clarity of goals are important to the learning process, according to educational psychology. The results of such a test furnish good material for use in setting up motivation and goals for the individual student. At the same time it provides the basis for some degree (the amount would necessarily vary with the number of students per instructor) of individualization of the teaching process.

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[1] This outline is not given because it is lengthy and not considered especially valuable. A good outline of the functional needs of students in this field is given in *A College Curriculum Based on the Functional Needs of Students* by Heaton & Koopman, University of Chicago Press.

While it is very easy to see the values which a good diagnostic health test might have, it is not a simple matter to develop such a test. The test given to Antioch students entering in the fall of 1937 was the fifth revision of the test in two years. It is still far from being a good test since the refinement of such a testing procedure is a slow process. Hence the results reported here must be viewed in the light of being some general observations gained from an imperfect testing device in the process of attempting refinements.

In the work with the diagnostic tests, standard procedures have been followed in attempts to determine the validity and reliability of the tests. The work has been handicapped and slowed down by reason of the relatively small numbers tested and lack of funds to do all the analysis believed necessary even for the numbers involved. Since the purpose of this paper, however, is to discuss only some experimental approaches to health education with some of the attending results, which are believed to be of general interest, the discussion of research technique will be minimized.

Will college students who are required to take a broad cultural program receive, indirectly, an adequate background of health information?—It is a possible assumption that if a liberal arts course is sufficiently broad, and if the curriculum has been properly formulated around the needs of the student, that provision has been made for educational development to take place in most of the necessary directions—including the personal and community aspects of health. Antioch students are required to take ninety-two credit hours of work of a general cultural nature, including six hours of physical education (three-year program),[2] twenty-four hours in the social sciences, and thirty hours in the general sciences. What was this extensive program accomplishing in the way of educating students in matters of health?

While the first work in 1935–36 with diagnostic health knowledge tests was undertaken only as an experiment with test forms and items, it seemed a good opportunity to see something of what the required course program was contributing to health education.

No hygiene courses were included in the general curriculum at Antioch until 1936. Hence, when the first two editions of the test were tried out on the incoming freshmen in 1935, the results from giving the same tests to a group of upperclassmen, selected at random, made an interesting comparative study.

The first test constructed was given in September 1935 to 103 enter-

[2] "A Program of College Physical Education and a Study of Its Carry-over Effects," *Journal of Health and Physical Education*, IV:1 (January, 1933).

ing freshmen students (Division A registration).[3] As a check, 32 upperclass students (mostly from the third, fourth, and fifth years) voluntarily took the test. In a space of five weeks' time these tests were all corrected, and on the basis of a very rough analysis of the results and comments which appeared on the tests, the test was revised in time to give it to 91 entering freshman students in October (Division B registration). Thirty-seven students in the upper classes also took this revised test.

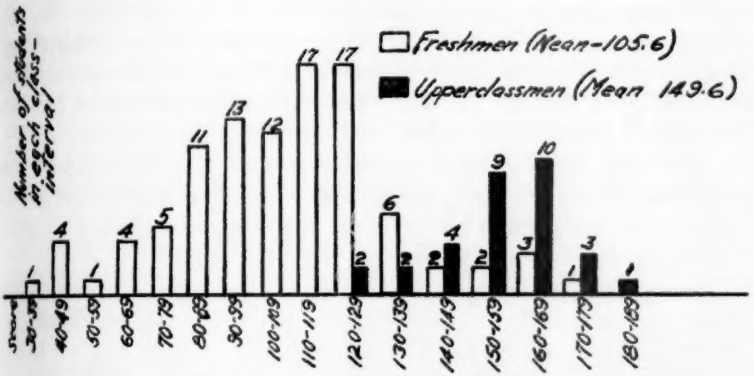

Chart I Showing Distribution of Scores for Freshmen and Upperclassmen on Second Edition of Diagnostic Health Test

Chart I shows the relative distribution of the two groups on the basis of the total right responses for those taking the second edition of the test. It is noticeable that the peaks come at higher points, in terms of score, for the upperclassmen than for freshmen. The mean score for the test for 91 freshmen was *105.6;* for the 37 upperclassmen, *149.6.* (The test contained 214 items.)

Whether this superiority is something of a reality founded on any scientific background of information or whether it is merely an apparent superiority based upon half knowledge, hearsay, or a little shrewder ability to guess the desired response, is difficult to prove one way or another. As to possible evidence that such superiority, where demon-

[3] The cooperative plan of education as applying to all departments of the Liberal Arts College is used at Antioch College, Yellow Springs, Ohio. This plan provides that students alternate periods of practical work. Two students fill a single position in some industrial, commercial, or educational organization, one working while the other studies on the campus. Every five or ten weeks they change places. On this basis, a student is enrolled at the college for either five or six years before attaining his degree. There is a possibility of a student completing his course in five years by applying one year in full-time study at the college.

strated, might have some real basis, there seem to be three plausible general explanations.

1. *Wider cultural stimuli.*—In addition to a wide academic program, Antioch students spend about three-fifths of each year engaged in regular employment in business, teaching, social work, industry, or various other pursuits. Students who have spent two, three, or four years on this cooperative plan have been exposed to much wider cultural stimuli than is the case for the average freshman just out of high school.

2. *Increased ability to reason.*—Coupled with these wider cultural stimuli one might expect an increase in ability to reason. Whether this ability will actually follow as a natural corollary is too much to say. One *hopes,* however, that college training will function to make students more analytical in their thinking. One *might* expect, therefore, that college seniors should be a bit less credulous than freshmen.

3. *A more capable group due to elimination of poorer students.*—It is possible also to infer that any group of upperclass students represents the more capable persons surviving the selective process operating in the first two years of college work.

In any event, if any superiority that is demonstrated in the test by these upperclass students is based upon actual knowledge plus reasoning, the point to be made is that it is due to general training and not to any specific training in health matters.

There is evidence, on the other hand, which might well indicate that perhaps where superiority does occur it is due to some of those things mentioned—half-knowledge, hearsay, or better guessing—rather than to any actual gain in validated understanding. For instance, less than half of the upperclass students saw the fallacies involved in several common superstitions. General conceptions concerning immunization theories, techniques, and applications are not well understood by upperclassmen.

In general, the conclusions reached from this particular study were:

1. That upperclassmen, as a group, make a better showing on this test than freshmen, without having any special training in health. That this result may be accounted for in part by (a) wider training, (b) increased ability to reason, and (c) the fact that these people are a more capable group due to the elimination of poorer students.

2. It was not demonstrated, however, that the type of general training given was accomplishing all that was conceived to be desirable in the basic outline covering the minimum essential knowledge of health. The need, therefore, for some type of special attention to health education, for students, seemed to be indicated. Since a high percentage of entering students stay in college only one or two years, it seemed important that this type of education be attempted early in the college course.

How much will college freshmen do, on their own volition, to improve their status, if they are made individually aware of the areas in which they show health knowledge deficiencies?—In the search for ways and means of making education a "self-administered process"; of putting the burden of proof more directly on the individual student to see what he needs and to get it for himself, it was deemed a very desirable thing to find out what students would accomplish for themselves in health education without the use of any conventional classroom teaching procedure, and given no credit or grades.

The Method.—All entering students in 1936 were given the third revision of the diagnostic test. After the tests were scored the average scores for each section of the test (nutrition, sex, infections, activity, etc.) were computed. These average scores for the sections were put on the title page of corrected copies of the test and sent to each faculty adviser along with individual summary sheets for each one of his advisees which showed the complete score on every test section, as well as the decile placement, for each student. When the adviser had conferences with students he could point out to them the specific knowledge areas in which they were low; how they stood in comparison to the class in each area and their decile placement on the whole test. The adviser was also furnished a bibliography indicating where information might be secured on various matters, and so could suggest to students where they might get whatever information they wished. All the material on the bibliography was put on a special shelf in the library for easy access. It is well to point out that the faculty advisers were not expected to do more than motivate their advisees in pursuing such study, but students were made aware that the college physician and all members of the staff in the Health and Physical Education Department would be glad to aid them in their study. Also, they were told that their achievement would be measured at the end of the school year to see what improvement in their knowledge had occurred.

Fifty-four of the freshmen students were in an elective course in educational guidance in which, as part of the course requirements, they read one book on health.[4] In analyzing the results of the tests these students are separated from the others for purposes of comparison and are designated the "special group."

The test given at the end of the year was not the same one given at the beginning. It is recognized that for more exact comparisons, the end testing procedure should have included the first test. This was not done for the reasons that (1) there was a lack of sufficient finances to do all the necessary statistical analyses on even one test; (2) the expediency of experimenting with an achievement test form outweighed a

[4] Harold S. Diehl, *Healthful Living*.

purely research approach in measuring the results achieved during the year. Thus in presenting the results, since the raw scores of the two tests would be difficult of comparison, the scores for both tests are given in terms of the per cent of correct responses. In making a comparison on such a basis the assumption has been made that the tests were of comparable difficulty. In the achievement test the use of a limited number of true and false items and an increase in the number of multiple choice,

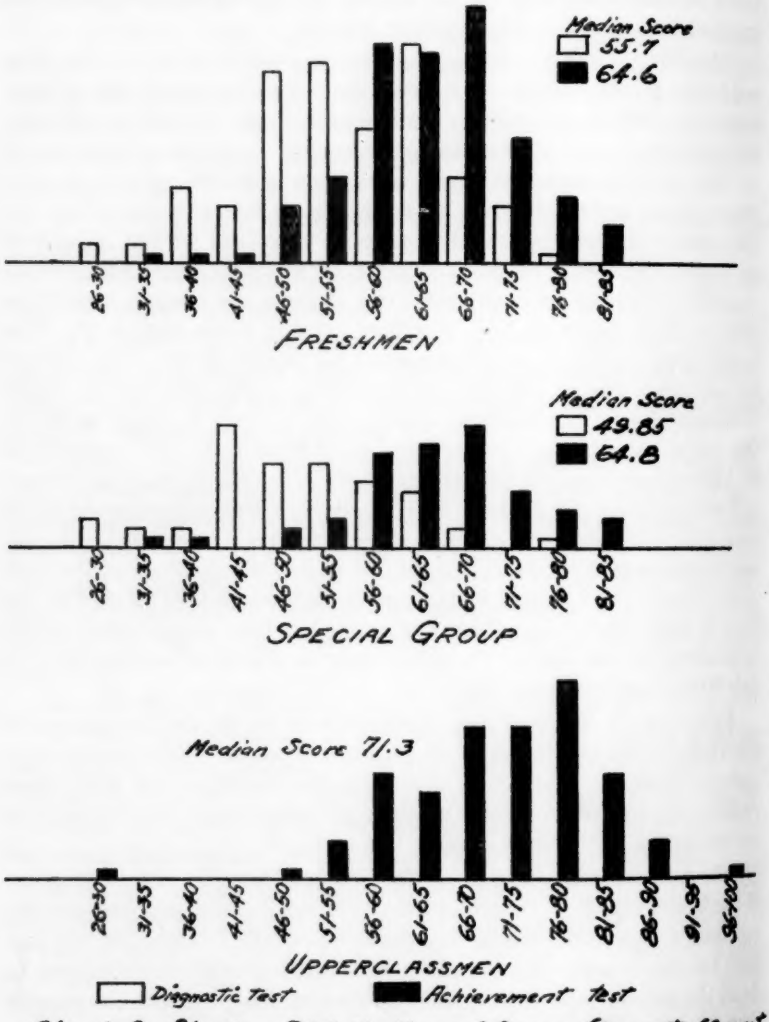

Chart 2 Showing Distribution of Scores (Percent of Correct Responses) on Diagnostic and Achievement Health Tests

identification and selection, and matching items reduced the chance factor in guessing the correct response over what it had been in the diagnostic test. This element coupled with the use of a slightly larger number of items (diagnostic test, 200; achievement test, 230), would indicate that the two tests were not of equal difficulty but it is believed that they were sufficiently comparable to indicate general trends if nothing else. The results given below, then, can be regarded only in that light.

The Results.—The distribution of scores for the diagnostic test and the achievement test shown in Chart II is for (1) the 114 freshmen who had no special training, but who were acquainted with their performance on the diagnostic test and urged to study, on their own initiative, with no grades or credit given; (2) the "special group" of 54 freshmen, who, in addition to being urged to study on their own initiative, read one book on health as part of a course requirement. The score distribution for 96 upperclass students (fourth, fifth, and sixth years in college) on the achievement test is also shown to indicate relative standings.

It will be noticed that the score distribution and median score (49.85) for the "special group" on the first test were at lower levels than they were for the other freshmen. This "special group" was composed of students who elected, either independently or upon the recommendation of their advisers, to take a freshman course in educational guidance. It was in this course that some reading on health was done. Among the group electing this course were many who tested below the average on the battery of scholastic aptitude placement tests given to all freshmen. The distribution of scores for this group on the diagnostic health test was, in general, comparable to the distribution for this group on other tests.

The score distribution on the diagnostic test for the rest of the freshmen shows a higher percentage of correct responses for the larger number of students with a median score of 55.7.

On the achievement test, however, both groups show an almost exact similarity of score distribution, while the medians are practically identical (64.6 and 64.8). It is seen that both groups have made some gain in the percentage of correct responses made, but the larger gain is for those students in the "special group."

To ascertain what this gain meant in terms of the test scores for individual students a graph was made for both groups showing the distribution of the scores by individuals from the lowest to the highest scores on the diagnostic test. The individual's score on the achievement test was then superimposed. From this graph are taken the gains and losses for the two groups shown below. (Gains and losses represent increments expressed in the per cent of correct responses.)

CHART III

NUMBER OF STUDENTS RAISING OR LOWERING THE PER CENT OF CORRECT RESPONSES ON ACHIEVEMENT TEST AS COMPARED WITH DIAGNOSTIC TEST

	Freshmen		Special Group	
	No. of Students	Per Cent of Group	No. of Students	Per Cent of Group
Increase of 11 or over	46	40	36	66
Increase of 6 to 10	28	24	9	16.5
Increase of 1 to 5	25	23	9	16.5
No gain or loss	3	13	0	
Loss of 1 to 3	5		0	
Loss of 4 to 6	5		0	
Loss of 7 to 20	2		0	

While 13 per cent of the general freshman group either made the same percentage of correct responses or dropped in their score, none of the "special group" came in this category. Sixty-six per cent of the "special group" made gains of between 11 and 46 percentage points as compared to 40 per cent of the freshmen making gains of between 11 and 51 points. In terms of averages based on performance of the entire groups, the general freshman group shows an increase of nine percentage points on the achievement test over the diagnostic; the "special group," 14.6 points.

The two groups were combined in arranging the decile distribution for the two tests, hence the results for the groups may be expressed in terms of deciles also. The net results of the performance of the two groups in terms of deciles show an average net gain of 1.05 deciles for the special group and an average net loss of .44 deciles for the general group.

CHART IV

GAINS AND LOSSES IN DECILE PLACEMENT ON THE ACHIEVEMENT TEST AS COMPARED WITH DIAGNOSTIC TEST

	Special Group	Freshmen
Total number of students	54	114
Number of students gaining	28	33
Total deciles gained	80	81
Average gain	1.49	.71
Number of students unchanged	14	27
Number of students dropping	12	54
Number of total deciles dropped	24	134
Average drop	—.44	—1.15
Net gain or loss	+1.05	—.44

The "special group" consisted of 22 women and 32 men students. The general freshman group had 42 women and 72 men students. A special breakdown of the results of the two tests to see whether there were any significant differences in any of the factors being studied between men and women students indicated such slight differences as to be negligible. Neither was there any significant difference between the achievement of the upperclass men and women students taking the achievement test (57 men, 39 women).

What answer can one derive from these results in terms of the question raised, "Will college freshmen voluntarily study to improve their health knowledge status?" The general freshman class did improve somewhat as a group during a year. Considered individually, however, 13 per cent either showed no improvement or lost ground and 47 per cent showed gains of only 10 per cent or less. Could the gain made be due to study or to other factors? The fact that upperclass students make a relatively better showing on these tests than entering freshmen without having any special training, as shown in the first part of this paper, and again on this test, could indicate that the improvement made by freshmen was only that part of a general improvement occurring in the first year which might be expected to take place without special study.

It is too early to report upon a factor presumably associated with such improvement, as the study is only now in process, but there is a strong suggestion of a high correlation between the results on the diagnostic health test and those on a general vocabulary test given to entering freshmen. Difficulty with general vocabulary, as distinguished from the specialized vocabulary of the field, seems to be an important factor in performance on these tests. It may well be that some part of the superiority of upperclass students on these tests is accounted for by a more facile understanding of the meaning of words in general. Such a factor, assuming that there is improvement in general vocabulary usage in the first year, could account for some part of the improvement in the freshman group without involving any special study in health.

The graph plotted to show the relative performance on the two tests for each student shows no significant differences as to improvement between the people scoring low, in between, or high on the first test. What improvement there was in the group as a whole occurred in about the same relationship of magnitude for any section of the distribution. An occasional student shows wide variation, but the general pattern indicates something of a general but small growth that might be as readily explained by other factors as by study.

That there was a relatively larger improvement made during the year by the "special group," as a group, seems clearly indicated. The actual reading was done by this group in the first semester, whereas the achievement test was not given until the end of the second semester,

allowing time for a good deal of the material to be forgotten. This factor must be weighed in evaluating the performance. While the other factors which affected the score of the general freshman group were also operating here, it seems probable that the reading done by these students did enable them better to verify their guesses on the achievement test and as a group to demonstrate a relatively greater improvement as compared with the general freshman students. It must be noted, however, regarding this reading, (1) that it was done because it was required in a course, and (2) because time was specifically provided for it in the student's program by giving credit for the course in which the reading was done, and (3) that individual performance may have been motivated in some degree by being graded in the course.

CONCLUSIONS

Antioch freshmen students do not, as a group, seem motivated to improve their knowledge of matters related to personal and community health on their own initiative and time and without credit and grades. This result obtains even when the areas in which these students were deemed to have insufficient background were pointed out to them; when an attempt was made to motivate them by pointing out the especial values of such knowledge; and in view of the fact that they knew they were to be retested.

When credit and grades are given for a course only indirectly related to health, but which required some reading in health, there resulted a gain in health knowledge which could be ascribed, in part at least, to the reading done.

To find out whether Antioch freshman students will undertake autonomously to study materials related to health (i.e., independently of the traditional classroom procedures), provided that credit and grades are given (thus making time available in the student's program, as well as furnishing a further stimulus), is the object of a study being conducted this year.

A Convenient Apparatus for the Study of Motion Picture Films

By Ruth B. Glassow
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MOTION pictures have been used by psychologists for several years to study infant behavior. The advantages of this method of study are stated by Gesell: "By projection a record can be reviewed at any time or any number of times. It can be revived in part or in entirety; at a slowed rate or a speeded rate and even in reversed eventual order . . . any moment of the sequence can be halted for separate scrutiny, any phase can be repetitively revived."[1] The motion picture enables the user to see stilled pictures of various phases of an activity and to compare details at his leisure.

Fenn used motion pictures to study factors in running.[2] For purposes of projection and measurement an improvised lantern was used and the pictures projected on a screen. In preliminary measurements the chief source of error lay in the buckling of the film. To avoid this the film was passed between two glass plates which could be clamped tightly together when the desired frame was brought in front of the lens.

In 1931 Halverson described a work table for the study of films. He used an Eastman 6-volt, hand-cranked, Model C Kodascope equipped in a 1" lens. This was mounted beneath a table within easy reach of the left hand in such a manner that with the aid of a mirror it projected a 2½" by 3" image upward on a ground glass set in the lower left hand corner of the table top, which tilted forward at an angle of 30°.[3] When a tracing was desired the ground glass was removed in favor of a clear glass upon which a paper was placed. Halverson modified the Model C Kodascope to permit movement backward.

This method has two advantages over that used by Fenn. The first is that the projected image is on a table instead of a screen and the tracing is done on a surface which is more nearly horizontal (tilted to a 30° angle) rather than one which is perpendicular. The second advantage lies in the proximity of the projector and tracing surface, which are so placed that the observer can, without leaving his seat, make the

[1] Arnold Gesell, *Infancy and Human Growth*, p. 68.

[2] Wallace O. Fenn, "Work Against Gravity and Work Due to Velocity Changes in Running," *American Jour. Physio.*, 93; 433–462.

[3] For pictures of this apparatus see H. M. Halverson, "A Projection Table for Studying Motion Picture Films," *Am. Jour. of Psych.*, 43, p. 120.
Arnold Gesell, *Infancy and Human Growth*. p. 68.

tracings and manipulate the projector. These two advantages are, however, at the expense of the size of the image projected, and to study in detail movements of various parts of the body during different activities, a larger picture than the one given by Halverson's setup may be desired. It was found by preliminary experimentation that when small images were traced the analysis was extremely difficult due to the overlapping of the tracings. When the picture was enlarged there was a greater spread and the lines of various parts of the body were much more easily followed. However, while enlarging the images, the convenient relationship of projector and tracing surface should be maintained. Our problem then was twofold:

1. To be able to vary the size of the picture.
2. To have the projector in such a position that it can be operated without a shift of position by the person making tracings.

The size of the image can be varied only by changing the distance of projection. Since it is desired to keep the tracing surface and projector convenient to each other this distance can be changed only by varying the distance between the projector and mirror, mirror and image, or both. Any change in the distance of the mirror from the other parts of the apparatus necessitates a shift of its angle to keep the image reflected on the tracing surface. When the angle of the mirror is changed there must be a corresponding shift in the angle of the tracing surface to prevent distortion of the picture. This distortion may be so slight that it is not distinguishable by the eye, but it can be detected when measurements are taken of the size of the picture and the proportions compared to a straight projection on a screen.

The apparatus and formulae presented here give an image which can be projected to the desired size without distortion, and provide a surface convenient for tracing and manipulation of projector.

To provide a convenient and adjustable tracing surface the following apparatus has been designed. (See Illustration I) A piece of ground glass 16″ x 20″ (1)* is mounted between two boards (2) and fitted into grooves on uprights of a frame. Thumb screws (3) can be tightened to hold the glass securely at any desired height or can be loosened to permit changing the height. The ground glass must be mounted in a manner which permits easy rotation on a horizontal axis to provide changes in the angle of the tracing surface. This has been done by attaching the middle of each side of the ground glass frame to a piece of brass (4) which in turn is fastened by a thumb screw (5) to each of the sliding boards (2). Loosening the screws permits adjustment of the angle of the tracing surface.

With a horizontal tracing surface, the projection rays must approach

* Numbers in parentheses refer to corresponding parts of the apparatus, as shown on the illustrations.

the glass, from below. This may be done either by placing the projector below the tracing surface or by placing it above and reflecting the

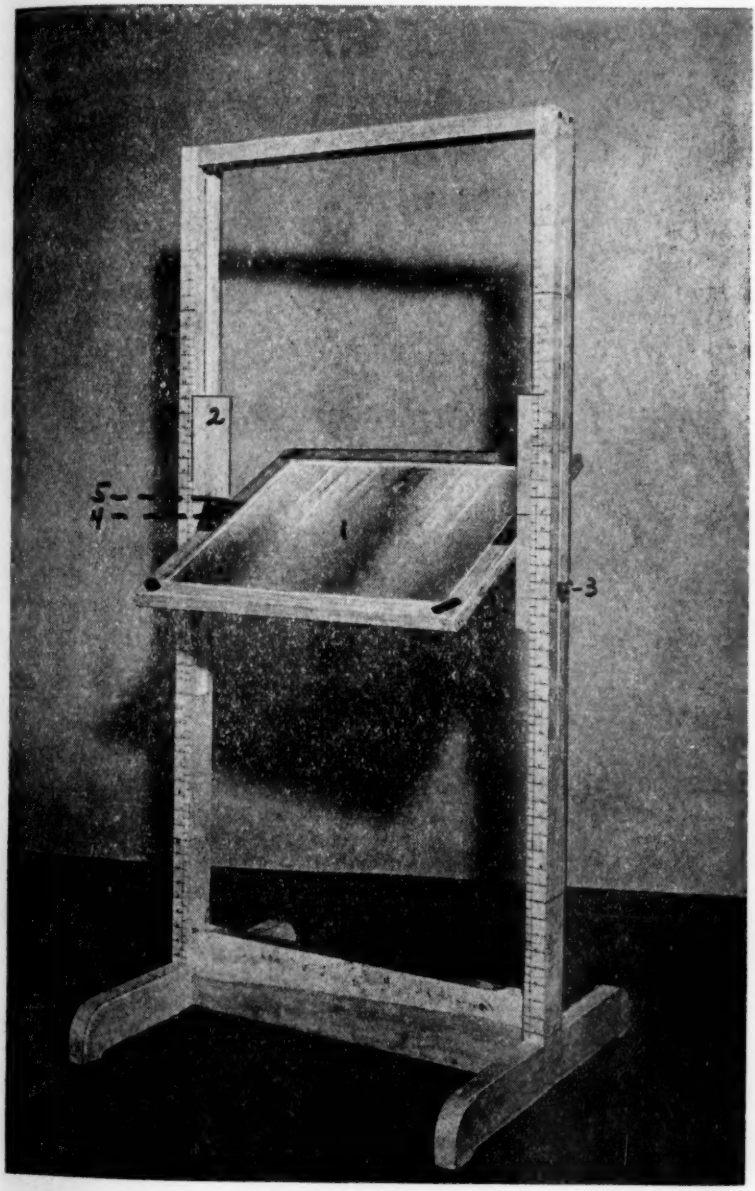

ILLUSTRATION I

projected rays upward from a mirror. The latter has been employed in this apparatus. (See Illustration II) It is, therefore, necessary to provide a support for the projector above the mirror which will hold it in

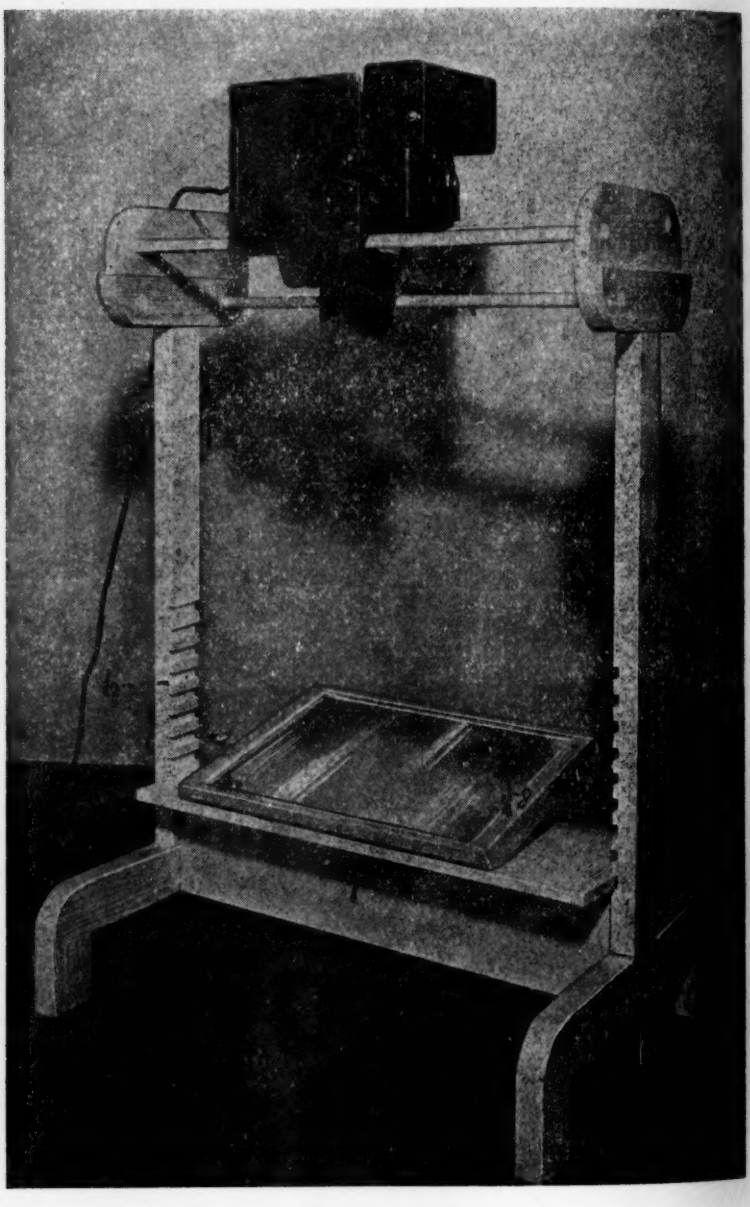

ILLUSTRATION II

such a manner that the light will be projected downward perpendicular to the floor instead of in the usual horizontal direction. The uprights of the frame which supports the projector also support a mirror. This

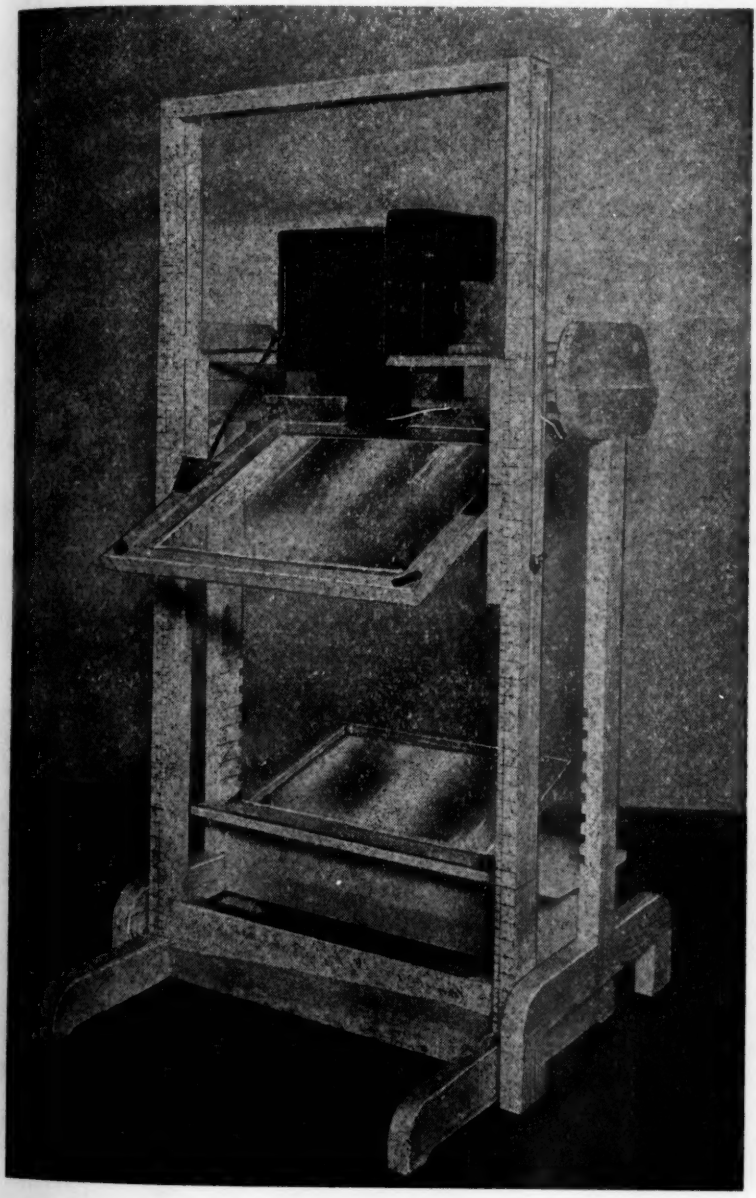

ILLUSTRATION III

mirror 12″ x 18″ is hinged to a board (28⅝″ x 9½″ x ⅝″) which fits into grooves in the uprights of the frame (6). These grooves run from 9½″ to 21″ from the floor and are ⅝″ apart. If the crosspiece of the frame (7) is removed, the mirror may be placed on the floor. Two thumb screws 2½″ long (8), will hold the mirror at any desired angle.

For analysis of films, the two frames are moved together (See Illustration III) so that the projector lens (center) is 10″ above and 1′ forward of the center of the ground glass. This provides a convenient height for tracing and places the hand crank of the projector within easy reach of the operator.

The ground glass is used because its translucency diffuses the light rays sufficiently to make an image. When tracings are made on a thin paper, a clearer image is obtained if the ground glass is replaced by a clear plate glass.

The following steps are necessary in setting up the apparatus:

1. To know the size of the image desired.
2. To find the distance of projection necessary to give the above image.
3. To find the height at which the mirror must be set to give this projection distance.
4. To find the angle of the tracing surface which will give no distortion of the picture.
5. To find the angle of the mirror necessary to keep the image on the tracing surface.

1. and 2. The size of the image varies in proportion to the distance of projection. Therefore, the distance necessary for any desired image may be easily calculated from the known projection distance and size of the smallest image which it is possible to focus with a given projector. For example, suppose that an image 6″ x 8″ is the smallest possible for good focus and to give this size image the projector lens is 4′ from the screen. If you wish to increase the size of the image 50 per cent, or to 9″ x 12″, the projection distance must be increased 50 per cent, or to 6′.

3. The height of the mirror is determined by finding the distance from the mirror to the lens of the projector. This is given by the formula:

$$\text{distance from mirror to lens} = \frac{S^2 - 144}{2S} + 10$$

in which S is equal to the total distance of projection minus the constant distance of the projector lens above the center of the tracing surface (in this apparatus 10″).

4. The angle of the tracing surface with the horizontal may be found by the formula:

$$\text{tangent of } \angle \text{ of the tracing surface} = \frac{24S}{S^2 - 144}$$

5. The angle of the mirror with the horizontal is always one-half of the angle of the tracing surface with the horizontal:

$$\angle \text{ of mirror} = \tfrac{1}{2} \angle \text{ of tracing surface.}$$

Example.—

1. Picture approximately 8½ x 11 desired
   Length of projection 5′ (60″)
2. $S = 60'' - 10'' = 50''$
3. Distance from

$$\text{mirror to lens} = \frac{S^2 - 144}{2S} + 10 = \frac{2500 - 144}{100} + 10 = 33.56''$$

4. Tangent $\angle$ of ground glass $= \dfrac{24S}{S2 - 144} = \dfrac{24 \times 50}{(50)^2 - 144} = \dfrac{1200}{2356} = .5093$

   $\angle$ of ground glass $= 26°59'$
5. $\angle$ of mirror $= \tfrac{1}{2}(26°59') = 13°29.5'$

Note: The position of the projector lens in relation to the ground glass is set by the apparatus. The center of the lens is 10″ above and 12″ forward of the center of the ground glass.

Proof.—

A. To find the distance from the center of the mirror to the projector lens:

1. $X + Z = S$ total distance of projection minus R (distance of lens of projector above the tracing surface = 10″)
2. $X = S - Z$
3. $X^2 = Z^2 + Y^2$ the square of the hypotenuse of a right triangle = the sum of the squares of the other two sides.
4. $(S - Z)^2 = Z^2 + Y^2$ substitution
5. $S^2 - 2SZ + Z^2 = Z^2 + 12^2$ (as apparatus is set up $Y = 12''$)
6. $2SZ = S^2 - 144$
7. $Z = \dfrac{S^2 - 144}{2S}$
8. distance from the center of the mirror to the projector

$$\text{lens} = \frac{S^2 - 144}{2S} + 10''$$

B. To find the angle of the ground glass:

1. $\angle p = 90°$ to avoid distortion the light rays must strike the glass at an angle of 90°
2. $\angle p + \angle g + \angle o = 180°$ 180° in a triangle
3. $\angle g + \angle o = 90°$
4. $\angle o = \angle e$ when two parallel lines are cut by a transversal the alternate angles are equal
5. $\angle g + \angle e = 90°$ substitution
6. $\angle b + \angle e = 90° - \angle w$ given as 90° and 180° in a triangle
7. $\angle g = \angle b$
8. the tangent of $\angle b = \dfrac{Y}{Z}$

9. the tangent of $\angle b = \dfrac{12}{\dfrac{S^2 - 144}{2S}} = \dfrac{24S}{S^2 - 144}$

10. the tangent of $\angle g = \dfrac{24S}{S^2 - 144}$ substitution

C. To find the angle of the mirror:

1. $\angle b + \angle c = \angle b + \angle d$ — the angles of incidence = the angle of refraction
2. $\therefore \angle c = \angle d$
3. $\angle b + \angle c + \angle d = 180°$ — straight line
4. $\angle b + 2\angle d = 180°$ — substitution
5. $\angle b = 180° - 2\angle d$
6. $\angle m + \angle a = 90° - \angle v = 90°$ and 180° in a triangle
7. $\angle a = \angle d$ — when two straight lines intersect, the opposite angles are equal
8. $\angle m + \angle d = 90°$ — substitution
9. $\angle m = 90° - \angle d$
10. $\angle m = \frac{1}{2}\angle b$ — steps 5 and 9
11. $\angle m = \frac{1}{2}\angle g$ — see B. 7

BIBLIOGRAPHY

1. Casdner, Burton Menaugh: "The Development of Fine Prehension in Infancy," *Genetic Psych. Man.*, 12 (August, 1932), 165–193.
2. Fenn, Wallace O.: "Work against Gravity and Work Due to Velocity Changes in Running," *Amer. Jour. Physiol.*, 93 (1930), 433–462.
3. Fenn, Wallace O., and C. A. Morrison: "Factors in the Work of Sprint Running," *Amer. Jour. Physiol.*, 92 (March, 1930), 583.
4. Gesell, Arnold: *Infancy and Human Growth.* (New York: The Macmillan Company, 1928), p. 68.
5. Gesell, Arnold: *The Mental Growth of the Preschool Child,* (New York: The Macmillan Company, 1926), p. 160.
6. Gesell, Arnold, and Helen Thompson: "Learning and Growth in Identical Infant Twins," *Genetic Psych. Man.*, 6 (July, 1929), 1–123.
7. Gesell, Arnold, and Helen Thompson: *Infant Behavior, Its Genesis and Growth,* (New York: McGraw-Hill Book Company, Inc., 1934).
8. Gilbreth, Frank B.: *Applied Motion Study.* (New York: The Macmillan Company, 1919).
9. Halverson, H. M.: "A Projection Table for Studying Motion Picture Film," *Amer. Jour. of Psych.*, 43 (January, 1931), 124.
10. Halverson, H. M.: "An Experimental Study of Prehension in Infants by Means of Systematic Cinema Records," *Genetic Psych. Man.*, 10 (August-September, 1931), 107–286.
11. McGinnis, John M.: "Eye Movements and Opti Nystagmus in Early Infancy," *Genetic Psych. Man.*, 8 (October, 1930), 321–430.

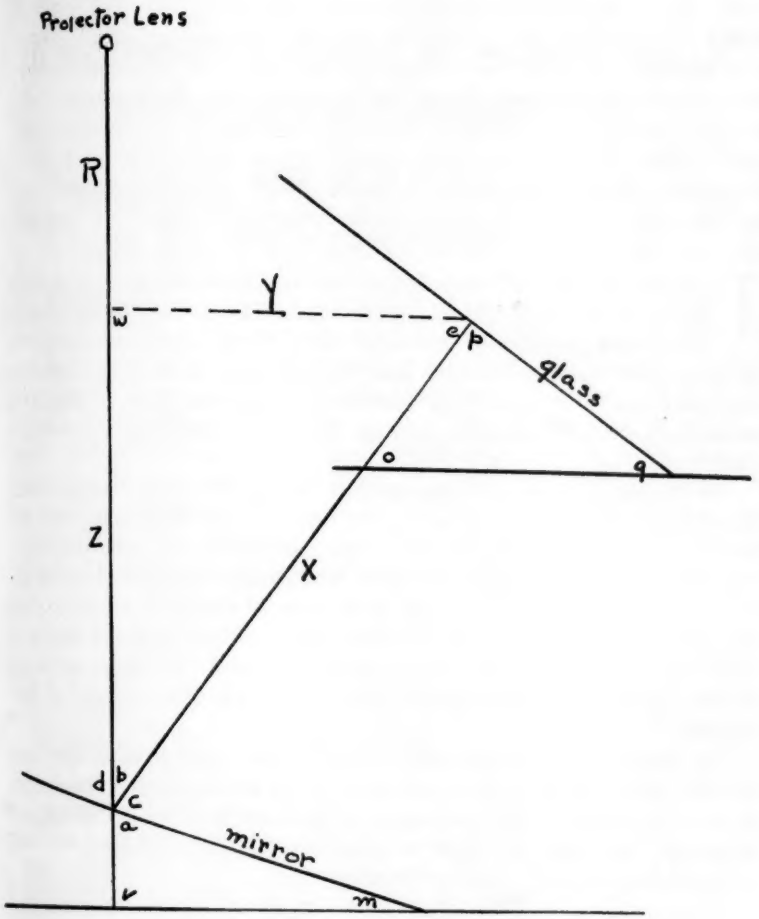

DIAGRAM OF THE DISTANCES AND ANGLES OF PROJECTION AND APPARATUS

X-ray Studies of Innate Differences in Straight and Curved Spines

By C. H. McCloy

State University of Iowa

IN 1926 Dr. Arnold stated that he had evidence gained through X-ray studies that (1) bad postural habits resulted in deformities only in the presence of "unsound tissue," and (2) the vast majority of all so-called postural defects were in effect bony deformities and were not amenable to treatment by exercises.[1] From that time to this, as a profession, we have rather ignored the X-ray as a tool of research in this field.

In the last four years a number of X-ray studies, as yet unpublished, have been conducted on the subject of various individual structural differences as related to posture. All of these studies indicate very strongly that there is a great range of what are probably innate individual differences of bony structure in almost all parts of the skeleton. That these are not due solely—or even in large part—to bad postural habits is shown by the fact that some of the same structural differences are found in the cartilaginous skeletons of infants from birth to the age of four months.

In the study of posture much attention has been given to the "correction" of excessive forward curvature of the thoracic spine (kyphosis), to an excessive backward curvature of the lumbar spine (lordosis), and to lateral curvatures of the spine (scoliosis). It is to the first two that we shall turn our attention in this paper.

THE PROBLEM

To what extent can we attribute different degrees of kyphosis and lordosis to innate or hereditary differences of structure of the spine and pelvis?

Two pieces of evidence are cited, based on studies made in the University of Iowa laboratories, utilizing the X-ray.

The Thoracic Spine.—Owing to the fact that the spine can not be readily seen in all its detail in X-ray pictures of individuals of extreme youth, we have limited our studies to post-adolescents. Of these we present two groups.

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[1] E. H. Arnold, "Bad Posture or Deformity?" *American Physical Education Review*, XXXI:9 (November 1926) 1058.

The first group studied was a carefully selected group of young adults. Three of these were brothers and sisters, all of whom were known to the author to have been the possessors of round backs from infancy. One parent, a grandparent, a great grandparent, and a great, great grandparent had all exhibited this trait. It is felt that in this group, at least, there is an hereditary structure. This group was composed of two males and one female. The contrasting group was selected because of the fact that the individuals had exhibited a hyper-straight thoracic spine from early youth. This group consisted of two females and one male. All were college students.

The second group studied consisted of ten senior high school boys and two teachers. Six of these may be considered to be individuals exhibiting a more than usual amount of round back. When they attempt to assume a straight posture, they do not succeed. We shall call them the "bent" group. Three of the group we might speak of as a "medium bent" group. They are not as round backed as the first group, but are more bent than the third. The third group of three might be spoken of as "medium straight." They are not on the average as straight as the second of the two "hereditary" groups, but would be considered as satisfactorily straight. All of them can assume an A or a B posture.

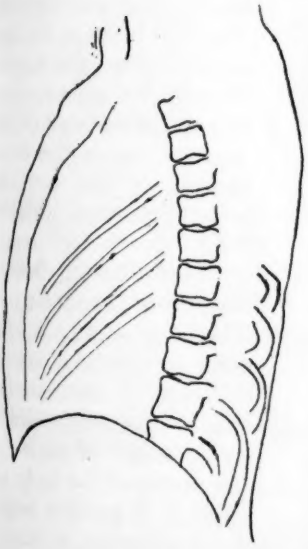

FIGURE I. "Bent" thoracic spine.

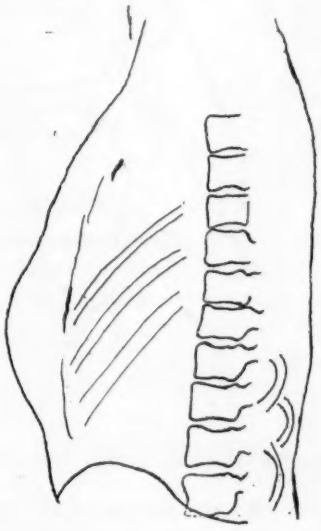

FIGURE II. "Straight" thoracic spine.

Each of the individuals studied was stripped to the waist, the arms were raised to the vertical and elbows flexed so that the forearms rested on top of the head. The individuals then forced the shoulders back-

ward as far as possible (to move the shoulder blades to the back of the trunk), and assumed as erect a posture as was possible under these conditions. They were then X-rayed laterally with the central rays planned to go through the eighth thoracic vertebra at right angles to the sagittal plane. The X-ray was planned to give as much detail as possible in the spine. Samples of one "bent" and one "straight" spine are shown in Figures I and II, line drawings made from the X-ray photographs.

Upon studying the resultant films it was found that in many cases the musculature and scapulae prevented a clear view of the spine above the fourth or fifth thoracic vertebra; and individual differences in the degree of upward projection of the diaphragm made it difficult to measure accurately in all subjects anything below the tenth thoracic vertebra. The study was therefore confined to the spine between the sixth and tenth thoracic vertebrae inclusive.

The following measurements were made on each vertebra. (1) The thickness of the body at the anterior edge. (2) The thickness of the body at the posterior edge. (3) The length of the body at the lower edge. (4) The distance between the articulations. This was taken as the distance between the top of the superior articular process of the vertebra below and the top of the same process of the vertebra being measured. (Figure III.)

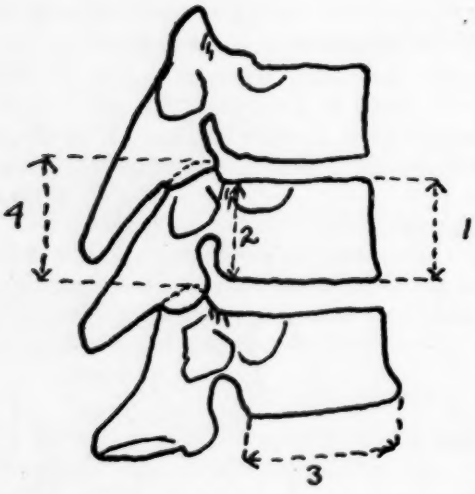

FIGURE III. Points used in measuring the vertebra.

The following indices were then computed. 1. Thickness of the posterior edge of the body minus thickness of the anterior edge of the body, divided by the length of the body. From this was computed the angle of the sagittal profile of the body of the vertebra. These are given in degrees in Table I. A positive angle means that the anterior edge is less thick than the posterior, as would be expected in most normal thoracic vertebrae. A negative value means that the posterior edge is the less thick. It would be expected that the round-backed groups would have larger positive angles on the average than the straight-backed groups. It will be seen that this is true.

TABLE I

AVERAGE ANGLES OF THORACIC VERTEBRAE

Vertebra	Hereditary Bent	Bent	Medium Bent	Medium Straight	Hereditary Straight
6	2°18′	6°12′	2°57′	—0°50′	1°13′
7	4°55′	6°04′	3°58′	0°45′	2°05′
8	5°13′	4°56′	4°52′	3°17′	0°53′
9	4°40′	4°34′	3°28′	2°38′	—3°52′
10	4°12′	1°43′	3°50′	0°03′	—2°33′
Average	4°16′	4°42′	3°49′	1°11′	0°27′

2. The second index was the thickness of the anterior edge of the body divided by the width of the articulation. These values will be found in Table II. In hereditarily round-backed individuals, it would be expected that this index would be smaller, and in the straight-backed ones it should be larger. This is found to be true.

TABLE II

WIDTH OF BODY OF VERTEBRA / WIDTH OF ARTICULATION

Vertebra	Hereditary Bent	Bent	Medium Bent	Medium Straight	Hereditary Straight
6	.820	.758	.840	.845	.871
7	.741	.722	.730	.858	.815
8	.732	.758	.721	.737	.851
9	.777	.758	.765	.782	1.022
10	.881	.794	.749	.786	.910
Average	.790	.758	.761	.802	.894

3. Since it might be considered that in the case of the round-backed individuals one had merely a slumping forward, with a resultant crowding together of the anterior lips of the bodies, the distance between each vertebra and the one below it was measured, and, to put them into comparable terms, these inter-vertebral distances were divided by the thickness of the anterior edge of the vertebra. The averages of these distances are seen in Table III, and it will be noted in general that the round-backed group has the edges of the vertebrae farther apart than the straight-backed group. This is further evidence of the fact that the

TABLE III

AVERAGE DISTANCE BETWEEN LIPS / THICKNESS OF ANTERIOR EDGE

Hereditary Bent	Bent	Medium Bent	Medium Straight	Hereditary Straight
.218	.194	.194	.124	.164

relative roundness or straightness is not simply a function of the posture at the time. Apparently the round-backed group *attempts* to stand straighter than does the straight-backed group.

4. To obtain a measure of the general roundness of the curve, the chord between the top of the articulation of the sixth vertebra and the top of the articulation of the tenth vertebra was measured, as well as the rise between this chord and the arc through the articulation farthest removed from the chord. This rise was divided by the chord, and the results are given in Table IV. It will be seen that the curve is progressively smaller as the groups go from the more round-backed to the straighter-backed group.

TABLE IV

RISE OF ARC

CHORD OF ARC BETWEEN TOP OF ARTICULATION OF SIXTH VERTEBRA AND TOP OF ARTICULATION OF TENTH VERTEBRA

Hereditary Bent	Bent	Medium Bent	Medium Straight	Hereditary Straight
.0617	.0586	.0435	.0423	.0178

The Lumbar Spine.—This part of the study is based upon a selection from over 100 X-rays of the pelves of college women. These films have been the basis of three studies which will be reported elsewhere. In the study of these films, however, it has been shown that pelves vary from a type that is high and shallow antero-posteriorly, with the sacrum high and far forward in the pelvis, and with a lumbar spine that goes almost straight upward, or upward and backward—the so-called hyperflat back—to the type of pelvis that is lower and deeper anteroposteriorly, with a sacrum that is low and far back in the pelvis and tilted forward, and with a spine that goes forward and upward, forming the type of curve frequently thought of as exhibiting the defect of lordosis. Since these differences are seen in the skeletons of infants, it can safely be assumed that they are innate differences and not due solely to postural habits. Five films were selected from each of the two extremes of this distribution of lumbar curvature. We believe that it can be assumed safely that these represent two extremes of hereditary differences. Since the films did not show clearly all of the lumbar vertebrae above the third, this study has been restricted to the lowest three lumbar vertebrae.

The same measurements were taken on these two groups as have been described above for the thoracic vertebrae. The results will be seen in Tables V to VIII respectively. It will be noted that the angles of the lumbar spines give greater *negative* values for the curved than for the straight spines. That is, the anterior edge of the body is usually

TABLE V

AVERAGE ANGLES OF LUMBAR VERTEBRAE

Vertebra	Lordosis	Straight
3	—3°11′	1°5′
4	—3°45′	—1°1′
5	—13°29′	—8°19′
Average	—6°48′	—2°45′

TABLE VI

WIDTH OF BODY OF LUMBAR VERTEBRA

WIDTH OF ARTICULATION

Vertebra	Lordosis	Straight
3	1.044	.946
4	1.162	.992
5	1.268	1.123
Average	1.158	1.020

TABLE VII

AVERAGE DISTANCE BETWEEN LIPS OF LUMBAR VERTEBRAE

THICKNESS OF ANTERIOR EDGE

Lordosis	Straight
.351	.401

TABLE VIII

RISE OF ARC

CHORD OF ARC BETWEEN TOP OF BODY OF THIRD LUMBAR VERTEBRA AND BOTTOM OF BODY OF FIFTH LUMBAR VERTEBRA

Lordosis	Straight
.1191	.0801

considerably thicker than the posterior edge in the curved spines. It will be noted that the index obtained by dividing the thickness of the anterior edge of the vertebra by the width of the articulation is larger for the curved spines than for the straight ones. On the average, the distance between the anterior edges of these vertebrae, including the distance between the fifth lumbar vertebra and the sacrum, is greater in the straight-backed group.

An auxiliary study was made of the flexibility and extensibility of fifty spines. In this study the tips of a pair of pointed wooden calipers were applied to the seventh cervical spine and the twelfth thoracic spine, and the distance measured at right angles at the midpoint of the greatest curvature of the thoracic spine. The individual was then told to flex the spine forward as much as possible, and in this position of

extreme flexion and curvature, this measurement was made again. The individual was then instructed to straighten the spine as forcibly as possible, and the curvature was again measured. Similar measurements were made on the curvature of the lumbar spine, measuring between the twelfth thoracic and the fifth lumbar spines. It was found in the individuals at the extremes of both groups that those who could flex the spine the farthest could not extend it as far as the average, while those who could extend the spine exceedingly straight could not flex it as far as others. The correlation, in the whole group, between extreme flexion and extension was .55 in the upper spine and .43 in the lower spine.

Before presenting the inferences that might be drawn from these studies, we should like to present the inferences that are *not* to be drawn.

1. We are not justified in assuming that posture is purely an individual matter and that nothing should be done about it, as J. F. Rogers seemed to imply.[2]

2. We are not justified in assuming that there is nothing to posture training anyway, and that we might as well forget it. In the opinion of the writer there is a great deal to posture training and the important thing is to find *what* to do.

3. We are not justified in assuming that all we need is a program of athletics, games or sports, and then posture will take care of itself. The fact that the best athletes frequently have the worst postures (evidence for this will be presented in the near future), would cast strong doubts upon this doctrine.

It would seem to the writer that we *are* justified in drawing the following inferences from these studies:

1. There is a wide range of individual differences of bony structure. Many of these differences are undoubtedly hereditary.

2. There is no one standard of curvature to which all individuals should conform.

3. There is need for discovering accurate methods of determining what is the correct standard of posture for each type and for each individual.

4. It is important, if possible, to find out how this individual standard may be prescribed without resource to the X-ray.

In addition to the studies presented here and based upon measurement, other studies have been made of X-rays of the spine and pelvis, taken both laterally and antero-posteriorly. In these studies each bone has been examined individually and subjectively. It is clearly evi-

[2] J. F. Rogers, "The Long and Short of the Carriage Business," *Journal of Health and Physical Education*, III:10 (December 1932) 11.

dent from such studies that in a large number of cases the two sides of a bone do not always grow at the same rate, or for the same length of time. Quite frequently one side will grow to a greater extent than the other. This may be due to differences in the nutrition of the bone, to the fact that the epiphysis unites with the diaphysis earlier on one side than on the other, or to epiphysitis on one or both sides. Which of these explanations is correct is not at present apparent. The same differences in the growth of the two sides of the body can be readily observed by looking carefully at the facial contour of adults. In almost everyone observed, one side of the face will be larger than the other, and in many cases the asymmetries are very marked. It is suggested that many of the individual postural differences in bony structure may be of similar origin; and, while this paper does not discuss the subject of scoliosis, on the basis of such subjective observations of X-ray films, the writer would like to suggest that many minor lateral deviations are probably due to bony growth asymmetries which probably can not be affected by corrective exercise. It may be that in the near future it will be considered unsafe to prescribe corrective exercise of any type for either lateral or antero-posterior curves without first obtaining X-rays of the spine to be treated.

The problem is much more complicated than is usually realized. Those attempting to prescribe individual treatment should be careful to know the facts about the individual before attempting rigid prescription. It is the opinion of the writer that at this time there is a much greater need to study the basic facts regarding individual differences in the structure of the body and its mechanics than to study how to "grade" posture by means of tests, although this problem may perhaps be relatively successfully attacked, particularly by approaching it through methods which measure poise and segmental balance and alignment rather than the actual measurement of curves.

It is, of course, recognized that a paper based upon as small a number of cases as is presented here can not be the basis for standards, or even for important conclusions. Owing to the cost of this type of study, however, it has been thought worth while to present this small series, primarily to stimulate investigation along similar lines in other laboratories.

The Status of Intramural Athletics for Men in State Teachers Colleges

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IN RECENT years, articles and books have appeared recommending procedures in the administration of intramurals. To what extent are colleges practicing the recommended procedures? This article attempts to answer this question with regard to four-year state teachers colleges.

It is reasonable to expect many differences in organization and administration of intramural athletics in teachers colleges since intramural athletics comprise one of the latest additions to the physical education program. This was found to be the case in a study of intramurals in state teachers colleges. However, if desired educational outcomes are to accrue, it is necessary to conduct such programs as efficiently as possible. This means not only making the most of available facilities but administering the program in light of certain standard procedures and policies.

THE STUDY

The data on present practices in intramurals was obtained by means of a questionnaire study on athletics for men in 100 four-year teachers colleges in the spring of 1936.

Ninety-eight out of 100 four-year state teachers colleges studied professed to have an intramural program for boys. The enrollment of boys in the teachers colleges studied varied from 75 to 1,700 boys, and the colleges were scattered quite uniformly throughout the United States. For purpose of comparison and to aid in discussion of various phases of practice, the colleges have been arranged into three groups according to enrollment of boys. The teachers colleges are also grouped according to geographical areas such as Northeastern, North Central, South, and West.

In order to survey present intramural practices in state teachers colleges it was necessary to examine certain factors which contribute to a successful intramural program. The factors which are discussed in this article are: the administrative control or the director of the intramural program, student intramural boards or committees, managerial systems, facilities and equipment, program, and awards.

The data in this article are taken from the writer's doctor's thesis at New York University, 1937, on the "Administration of Athletics in Teachers Colleges."

INTRAMURAL DIRECTOR

It is generally conceded that the responsibility for the intramural athletic program should be centralized under one person, regardless of whether intramurals are controlled as a separate unit, a division of the physical education program, or of the athletic department.[1] It is evident from a study of the information obtained on intramurals in teachers colleges that many teachers colleges do not think it important to have an intramural director, since only 58 of the 100 colleges state that they have a person acting in this capacity. The majority of the colleges which have a person heading up the intramural department are located in the Middle West and Pacific Coast states. As might be expected, more of the larger colleges have a person who acts in the capacity of intramural director, than the smaller colleges. No doubt many of the 42 colleges that do not have an intramural director follow the practice of having each varsity coach conduct the intramural program in his sport, or give the responsibility to students. Since the work of an intramural director probably requires ability for good organization more than it does a knowledge of coaching, it seems that a program which does not have a centralizing force has a weakness in its lack of unity.

The present practices in intramurals in this study were evaluated in light of standards on the administration of intramural athletics. The standards were selected from Hughes' study.[2] The study shows that if a college does not conform to the recommended practice of having an intramural director, it tends to disregard other recommended practices in intramurals. All evidence seems to point to the fact,therefore, that the present status of intramurals in teachers colleges could be improved if an intramural director was held responsible for the program.

INTRAMURAL COUNCIL

Thirty-one of the 100 teachers colleges studied have an intramural council. Membership to the council in these 31 colleges is gained in three ways; through student appointment by student organizations, election by students, and appointment by a physical education staff member. The athletic director acts as chairman of the intramural council in 25 colleges, a student in four colleges, and a physical education staff member in the remaining three colleges. The teachers colleges in the Southern area do not follow the practice of having a student intramural council as readily as do the colleges in other areas. Only 12 per cent of the teachers colleges studied in the Southern area follow this practice as compared to 28.6 per cent, 34.8 per cent, and 57.8 per cent in the North Central, Western, and Northeastern areas, respectively. The most common duties of the intramural council named by colleges include: formulating policies, eligibility, selection of officials, schedules, protests,

[1] C. L. Nordly, *Administration of Athletics for Men*, p. 92.
[2] W. L. Hughes, *The Administration of Health and Physical Education for Men in Colleges and Universities*, pp. 91–127.

and selection of teams. Since intramural athletics play such an important part in the college activities program it seems that a student intramural board, or council, wisely used, and probably advisory in character only, could assist materially in promoting interest in intramural sports.

MANAGERIAL SYSTEM

The most common managerial practice in all colleges studied, was the selection of a manager for each intramural sport. Twenty-nine colleges indicated that they followed this plan. Thirteen colleges followed the system of having only one intramural manager, who managed all sports for a period of one year. Only 17 colleges stated that they made provisions for unit or team managers. It is not the purpose in this article to make recommendations, but it seems advisable for the welfare of the intramural program that team managers, or captains who act in that capacity, be chosen. Many details can be settled outside the intramural office through such a unit manager plan.

INTRAMURAL SCHEDULES

Ninety-four of the teachers colleges studied indicate that they make provisions for intramural contests. The time when such contests are scheduled, with the per cent of teachers colleges following each plan, is given in Table I.

TABLE I

INTRAMURAL SCHEDULES

Time when intramural contests are scheduled	Per cent of colleges following plan
After school	19
After school and evenings	23
After school, evenings, and Saturdays	23
During the day	4
Evenings	6
After school and during the day	6
Evenings and Saturdays	1
During day, after school, evenings, and Saturdays	12

FACILITIES AND EQUIPMENT FOR INTRAMURALS

The teachers colleges are in need of more adequate facilities for intramural games, as shown by the data in Table II.

TABLE II

FACILITIES FOR CARRYING ON INTRAMURALS IN COLLEGES STUDIED

Facilities	Group I 34 colleges 75–224 boys	Group III 41 colleges 225–449 boys	Group III 25 colleges 450–1700 boys
Intramural field separate from varsity	3	3	6
Swimming pools	11	18	16
College gymnasium	32	41	25
No field for sports at all	1	7	2
No fall sports	4	4	10

The information gathered in the table indicates that intramural fall sports are lacking in some colleges, this lack being probably due to the emphasis put upon football practices. Facilities for swimming are not adequate. Provisions for tennis are not shown in the table, but the information reveals that better facilities are needed. Two colleges had no facilities for tennis and six colleges had only one tennis court. The average number of tennis courts (cement and clay), ranges between three and four courts per college.

Seventy-six of the 100 teachers colleges furnish needed equipment for intramurals, such as balls, bats, nets, etc. Intercollegiate equipment is used in many cases for intramural sports.

INTRAMURAL PROGRAM OF ACTIVITIES

The intramural activities program is shown in Table III.

TABLE III

INTRAMURAL ACTIVITIES OFFERED AND THE PER CENT OF COLLEGES OFFERING EACH ACTIVITY*

Sport	Group I 34 colleges Enrollment 75–224 boys	Group II 41 colleges Enrollment 225–449	Group III 25 colleges Enrollment 450–1700
1. Basketball	100	92.7	100
2. Football	8.8	12.7	4
3. Tennis	82.4	85.4	96
4. Volleyball	82.4	70.7	84
5. Baseball	50	48.8	84
6. Golf	47.1	43.9	72
7. Swimming	23.5	41.5	76
8. Touchball	47.1	39	44
9. Handball	32.4	36.6	56
10. Wrestling	17.6	36.6	60
11. Boxing	35.3	26.8	52
12. Soccer	29.4	26.8	20
13. Softball	17.6	24.4	16
14. Hockey	14.7	19.5	4
15. Cross country	8.8	14.6	32
16. Horseshoe	2.9	12.2	16
17. Bowling	2.9	0	8
18. Track	14.7	9.8	24
19. Shuffleboard	2.9	4.9	0
20. Ping-pong	8.8	4.9	12
21. Mushball	0	2.4	0
22. Croquet	0	2.4	0
23. Archery	2.9	2.4	12
24. Playground ball	0	2.4	0
25. Speedball	8.8	2.4	4
26. Badminton	5.9	0	4
27. Deck tennis	2.9	0	0
28. Decathlon	2.9	0	0
29. Water basketball	2.9	0	0
30. Basketball golf	2.9	0	0
31. Gymnastics	0	0	4
32. Lacrosse	0	0	4

* The table should be read: 100 per cent of the colleges in Group I offer basketball, 92.7 per cent in Group II, and 100 per cent in Group III; etc.

INTRAMURAL AWARDS

Individual intramural awards are given more frequently in the smaller teachers colleges, but the granting of team awards predominates in the larger colleges; trophies, certificates, numerals, and medals are the most common types of awards given. A trophy is given most often as the team award while a medal is the most common individual award. The data presented reveal that many colleges do not offer awards for intramurals.

The department of physical education furnishes awards in 32 of the 59 colleges responding, the college furnishes them in six cases, athletic association in 11, Lettermen's Club in one case, student organizations in six cases, business firms in one, Y.M.C.A. in one, and the Inter-Fraternity Council in one.

COST OF INTRAMURAL EQUIPMENT

The cost of equipment for each participant in intramural sports in 58 colleges was computed. The data reveal a wide range in money spent for intramural equipment. The average amount spent per student for intramural equipment in the smaller colleges is $1.38, as compared with $1.31 in colleges of the intermediate group, and $1.86 in the larger colleges.

HEALTH EXAMINATIONS FOR INTRAMURALS

At the time this study was made only 59 colleges of the 100 teachers colleges studied required students to undergo health examinations before permitting participation in intramurals. This in all probability is not the case at the present time. Since 1935 the Accrediting Committee of the American Association of Teachers Colleges has set up some rigid requirements on student health, one of which is the examination by a physician of every student at least once a year.

PARTICIPATION IN INTRAMURAL ACTIVITIES

Table IV shows the per cent of boys in each group of colleges who participate in the intramural program. Many factors may contribute to or detract from the interest in an intramural program. Facilities available, the time schedule, the staff, and the amount of instruction given to activities in the required class period all influence the factor of interest.

TABLE IV

AVERAGE PER CENT OF BOYS WHO PARTICIPATE IN RELATION TO TOTAL ENROLLMENT IN TEACHERS COLLEGES

Groups			Geographical Area			
Group I	Group II	Group III	Northeast	North Central	South	West
58.8	49.8	41.6	60	51.8	46	44.3

Standards for the Selection of Persons to Be Trained for Placement in Health and Physical Education

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INTRODUCTION

THE professional preparation of teachers of health and physical education may be improved by concentrating on selecting well qualified students. The lack of uniformity in selecting students to be trained for placement in health and physical education presents a real problem. Selection measures must receive careful study. Few question the quality when the demand exceeds the supply. No scarcity of licensed teachers exists now, and competition improves the quality of the candidate. The present affords opportunity to obtain well selected teachers. To do this, standards are essential. Standards improve in response to challenging problems. These problems may be solved by personal dictation or by using scientific techniques of educational research. Investigation assists in solving selection problems by listing the qualities essential to successful teaching. Among the factors to be evaluated, according to Brownell, the following are suggestive: moral character; engaging personality; interest in physical education; graduation from approved high school or equivalent; freedom from organic or functional defects; superior motor capacity; better than average motor skill; relatively high native intelligence; relatively high scholarship; and superior social ability.[1] With the hope of throwing some light on these factors, this study of standards for selection of people to be trained for placement in health and physical education has been made.

HISTORY

This study had its origin in a national study entitled, "The National Study of Professional Education in Health and Physical Educa-

A paper presented before the Teacher Training Section of The American Physical Education Association Convention, April 1937, New York City.

[1] C. L. Brownell, "The Present Status of Professional Preparation of Teachers in Physical Education," The Research Quarterly 3 (May 1932) 113.

tion."[2] The subcommittee of the national study in charge of selection standards submitted, at the Pittsburgh Convention of the American Physical Education Association, April, 1935, a list of standards which was approved and adopted.[3] The writer, as a member of the subcommittee, knowing that these standards would be used to evaluate the ability of institutions to prepare persons to teach health and physical education, and knowing that only one phase had been considered, continued the study, using the committee's report as the basis for the investigation.

THE PROBLEM

The problem was to formulate a set of standards in the selection of persons to be trained for placement in health and physical education which teacher-training institutions should require applicants to meet before or after they are admitted to the professional curriculum in health and physical education.

THE PURPOSE OF THE STUDY

The purpose of the study inheres in the statement of the problem.

METHOD OF INVESTIGATION

Description of Inquiry Form.—A special inquiry form on selection standards was devised for collecting data. The inquiry form was derived by creating standards suggested from these sources: interviews with 200 members of the profession; institutional catalogs; authorities; 150 teachers agencies' application blanks. The inquiry form was divided into three parts: I, standards proposed by the subcommittee; II, institutional information; III, 49 important suggestions proposed as standards of selection. The following list of phrases accompanied each suggestion:

a) Used now as a standard by our institution.
b) Welcomed as a standard by our institution.
c) Desirable for an admission standard.
d) Desirable for a retention in course standard.
e) Recommended as a minimum standard.
f) Recommended as an administrative standard.
g) Recommended as an optional standard.
h) Undesirable and unpractical for a standard.

The respondent evaluated each suggestion by a check mark under "yes" or "no" to all phrases applicable to the suggestion.

Circulation and Return of Forms.—The inquiry form was mailed to 161 colleges and universities, 65 teachers colleges, 10 private schools,

[2] N. P. Neilson, "National Study of Professional Education in Health and Physical Education," THE RESEARCH QUARTERLY 6 (Dec. 1935) 48-68.
[3] N. P. Neilson, *Loc. cit.*

49 directors of health and physical education, 48 superintendents of public schools, and 48 high school principals. The public school administrators represent samplings from the 1930 census.

Panel Jury Check List.—The reactions of the 195 respondents were tabulated and transmuted into frequency scores, ranks, and percentages for each proposed standard. From this information a panel jury check list was formed and mailed to the six members of the National Committee of the National Study.[4]

REACTIONS TO SUBCOMMITTEE'S ADMISSION STANDARDS

The reaction to the profession as a whole to the committee's report was significant and was included in the study. The subcommittee's report considered the following standards as essential—

Admission—

1. Graduation from accredited secondary school.
2. Rank in upper two-thirds of class.
3. Intelligence quotient of 100 or more.
4. Health examination.
5. Satisfactory oral and written command of the English language.
6. Satisfactory skill in motor activities.
7. Confidential character report.

Administrative—

1. Complete records on file of all students in training.
2. Names and copies of all tests to be filed by institutions.
3. Admission records open to inspection.

The profession desired to formulate definite policies with respect to the type of applicants admitted to training and favored some specific and equitable system of administering standards of selection. While the subcommittee's standards were considered desirable and practical, they were not all acceptable for minimum selection standards.

PRESENT STANDARDS OF SELECTION

Effective selection of college students is becoming more and more prevalent. The methods by which institutions select their students are many and varied. Considerable effort has been made to learn the present practices among the colleges and departments. The data in Table I summarize the findings and present the fifteen common methods of admission, the ten of retention in course, and the six of requirements for graduation.

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[4] N. P. Neilson, *Loc. cit.*

TABLE I

NUMBER OF INSTITUTIONS INCLUDING CERTAIN ITEMS IN THEIR ENTRANCE CRITERIA FOR STUDENTS MAJORING OR MINORING IN THE PROFESSIONAL EDUCATION CURRICULUM IN HEALTH AND PHYSICAL EDUCATION

Criterion	Colleges and Universities					Teachers Colleges			Private Schools		
	Frequency	Rank	Frequency	Rank	Percentage	Frequency	Rank	Percentage	Frequency	Rank	Percentage
Admission	2	3	4	5	6	7	8	9	10	11	12
1. Transcript of college credit	125	1.	87	1	92	34	1.	90	4	3.5	67
2. Statement of honorable dismissal	112	2.	78	2	83	30	4.	79	4	3.5	67
3. Graduation from accredited high school	111	3.	76	4	81	31	2.5	80	4	3.5	67
4. Transcript of high school credits	106	4.	75	5	80	27	5.	71	4	3.5	67
5. "C" average, jr. college, lower division	105	5.	74	6	79	26	6.	70	5	1.	83
6. Rank in high-school graduating class	104	6.	77	3	82	24	7.	63	4	3.5	67
7. Complete medical examination	103	7.	69	7	73	31	2.5	80	2	11.5	33
8. Body free from defects and injuries	86	8.	58	8	62	24	8.	63	4	3.5	67
9. Special students over 21 years of age	65	9.	42	10	45	21	9.	55	2	11.5	33
10. College entrance board examinations	64	10.	49	9	52	13	10.	34	2	11.5	33
11. Presents evidence of interest	47	11.5	39	11	42	7	14.	19	1	14.5	17
12. Recommendation by principal or others	47	11.5	33	12	35	11	12.	30	3	8.5	50
13. Applicant at least 16 years of age	44	13.	31	13	30	10	11.	40	3	8.5	50
14. Satisfactory skill in motor activities	32	14.	22	14	23	8	13.	20	2	11.5	33
15. Intelligence Quotient	28	15.	21	15	22	6	15.	15	1	14.5	17

Retention											
1. One point eligibility for practice teaching	69	1.	47	1	50	21	1.	55	1	6.	17
2. Freshman grade suspension standards	60	2.	41	2	43	16	3.	42	3	2.	50
3. Immediate treatment of remediable defects	55	3.	38	4	40	14	5.	27	3	2.	50
4. Probation if admitted by aptitude tests	53	4.	40	3	43	12	6.	31	1	6.	17
5. Med. exam. prior to practice teaching	50	5.	30	6	32	18	2.	47	2	4.5	34
6. Student grade suspension standards	45	6.	33	5	33	10	8.	26	2	4.5	34
7. Reasonable health habits requested	40	7.	25	7	27	12	7.	31	3	2.	50
8. Eighth grade norms in critical subjects	33	8.	17	9	19	16	4.	42	0	0.	00
9. Evidence of qualities of leadership	25	9.	18	8	20	6	9.5	16	1	6.	17
10. Evidence of social adaptability	19	10.	13	10	14	6	9.5	16	0	0.	00
Graduation											
1. No college credit for work done in college before graduating from secondary school	100	1.	71	1	76	25	3.	66	4	1.	67
2. Quality points necessary for graduation	92	2.	66	2	70	23	4.	60	3	3.	50
3. Grade symbols transmuted into honor points	91	3.	61	3	65	27	2.	70	3	3.	50
4. No credit for practical teaching experience	79	4.	48	4	51	28	1.	73	3	3.	50
5. Amount of credit granted for extension	58	5.	40	5	42	16	5.	42	2	5.	34
6. Medical examination prior to graduation	36	6.	23	6	24	12	6.	16	1	6.	17

TABLE II

THE REACTIONS OF THE 195 RESPONDENTS TABULATED AND TRANSMUTED INTO FREQUENCY SCORE, RANK, AND PERCENTAGE FOR EACH PROPOSED STANDARD

Selection Standards	Admission Standard			Retention Standard			Minimum Standard			Admin. Standard			Optional Standard			Undesired Standard		
	F	R	%	F	R	%	F	R	%	F	R	%	F	R	%	F	R	%
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Medical examination results	91	1	47	49	16	25	75	2	38	53	9	27	10	18	05	15	33	08
2. Additional medical examination	78	11	40	61	6	31	74	4	38	57	5	29	0	48	00	8	45	04
3. Med. exam. prior to acceptance	87	3	45	52	14	27	70	6	36	61	3	31	1	45	.5	10	41	05
4. Med. exam prior to graduation	43	39	22	55	12	28	49	32	25	49	18	25	7	32	04	25	12	13
5. Med. exam. prior to teaching	42	40	21	37	30	19	54	27	28	52	13	27	8	28	04	25	13	13
6. Health and physical vigor	66	25	34	58	10	30	70	7	36	50	16	26	9	44	05	3	40	02
7. Normal hearing	75	17	38	45	19	24	45	38	23	36	40	18	24	16	12	10	19	05
8. Insufficient eyesight	65	27	33	41	23	21	42	41	21	37	38	19	27	10	14	21	7	11
9. Sound vital organs	75	16	38	61	7	31	78	1	40	52	12	27	5	49	03	2	41	01
10. Extremities free from defects	72	20	37	53	13	27	62	17	32	47	21	24	17	31	09	8	30	04
11. Marked over-and underweight	53	34	27	40	26	20	28	47	14	26	46	13	34	4	17	28	5	14
12. Unsightly deformities	78	10	40	49	17	25	67	12	34	55	6	28	14	35	07	8	29	04
13. Emotional instability	79	8	40	68	1	35	69	10	35	49	17	25	14	36	07	2	42	01
14. Disfiguring facial defects	39	41	20	26	44	13	31	45	16	24	47	12	38	3	19	31	3	16
15. Marked speech defects	69	24	35	57	11	29	59	20	30	43	30	22	30	8	15	9	24	05
16. Disqualifying defects listed	70	23	36	40	24	20	55	25	28	64	2	33	19	22	10	13	14	07
17. Evidence of vaccination	73	18	37	51	15	26	59	21	30	48	19	24	12	38	06	8	31	04
18. Treatment of remedial defects	79	9	40	61	8	31	71	5	36	53	10	27	7	46	04	5	38	03
19. Respect health habits	61	28	31	67	2	34	63	18	32	51	15	26	15	34	17	11	17	06
20. Age limit of 16 years	75	14	38	34	38	17	66	13	34	42	32	21	18	24	09	18	8	09
21. Height of male applicant	27	48	14	6	49	03	12	49	06	8	48	04	40	2	20	56	2	29
22. Height of female applicant	23	49	12	8	48	04	13	48	07	7	49	04	45	1	23	65	1	33
23. Social adaptability	65	26	33	64	3	33	51	30	26	37	37	19	23	17	09	18	9	09
24. Qualities of leadership	60	29	31	64	5	33	40	43	20	37	39	19	27	11	14	17	11	09

25.	Skill in motor activities	76	13	39	59	9	30	62	19	32	24	29	22	18	29	09	10	22	05
26.	Interest and aptitude in work	83	5	43	64	4	33	67	11	34	43	31	21	12	39	06	1	46	.5
27.	Confidential report	91	2	47	43	20	22	64	15	33	48	20	24	18	26	09	7	33	04
28.	High school graduation	75	15	38	38	27	19	75	3	38	45	25	23	10	42	05	2	43	01
29.	Rank in upper-half of class	76	12	39	27	43	14	48	33	24	36	41	18	43	6	17	17	12	09
30.	Scholastic aptitude test	82	6	42	36	31	18	51	29	26	40	35	20	23	18	12	9	25	05
31.	College entrance examination	58	31	30	23	45	12	42	42	21	31	44	16	18	28	09	18	10	09
32.	Transcript of H. S. credits	84	4	43	38	28	19	69	9	35	60	4	31	10	43	05	5	39	03
33.	Probation for one semester	58	30	30	48	18	24	56	24	29	47	22	24	18	25	09	9	26	05
34.	Junior college or sophomore year	49	35	25	22	46	11	33	44	17	32	42	16	33	5	17	26	6	13
35.	"C" average, lower division	71	22	36	35	34	18	58	23	30	45	27	23	22	19	11	6	37	03
36.	Honorable dismissal	80	7	42	37	29	19	65	14	33	54	8	28	11	40	06	0	49	00
37.	College credit transcript	73	19	37	40	25	20	70	8	36	55	7	28	7	48	04	1	47	.5
38.	High school deficiencies	46	37	24	30	41	21	46	37	23	38	36	19	16	32	08	13	15	07
39.	No outside teaching credit	29	47	15	18	47	09	29	46	15	32	43	16	30	7	15	29	4	15
40.	Extension credit	48	36	24	34	37	17	47	34	24	42	33	21	24	14	12	10	21	05
41.	Special students	56	32	29	34	35	17	46	36	23	41	34	21	24	15	12	15	13	08
42.	Intelligence quotient of 100	71	21	36	36	32	18	43	40	22	27	45	14	29	9	15	10	20	05
43.	Eighth grade subject norms	54	33	28	42	21	21	55	26	28	45	26	23	18	27	09	11	16	06
44.	Quality point system	38	42	19	13	40	15	43	39	22	52	14	27	18	30	09	8	27	04
45.	First semester suspension	36	44	18	42	22	21	49	31	25	53	11	27	21	21	11	7	34	04
46.	Student suspension standard	36	43	18	32	39	16	46	35	23	46	24	23	21	20	11	9	23	05
47.	Teaching eligibility	35	46	18	35	33	18	53	28	27	46	23	23	19	23	10	7	34	04
48.	Eligibility for graduation	35	45	18	29	42	15	58	22	30	45	28	23	12	37	06	6	36	03
49.	Inspection for standards	45	38	23	34	36	17	62	16	32	65	1	33	7	47	04	2	44	01

TABLE III

RECOMMENDATIONS OF THE JURY PANEL FOR SELECTION STANDARDS

1.	Selection Standards	Admission 3.	Retention 4.	Minimum 5.	Admin. 6.	Optional 7.	Undesirable 8.	Total 9.
1	File results of medical examination			5				5
2	Additional medical examination			5				5
3	Medical examination prior to admission			5				5
4	Medical examination prior to graduation		2		1	2		5
5	Medical examination prior to teaching			1	2	2		5
6	Present evidence of physical fitness			5				5
7	Normal hearing in both ears	4		1				5
8	Sufficient eyesight (20/40) for ball games	4		1				5
9	Sound vital organs			5				5
10	No defects or injuries of extremities	4	1					5
11	Over weight and under weight may reject	4	1					5
12	Unsightly deformities may reject			5				5
13	Emotional instability cause for rejection	1	4					5
14	Facial defects may cause rejection	4				1		5
15	Marked speech defect cause for rejection			5				5
16	Publish list of defects causing rejection				1	4		5
17	Present evidence of recent vaccination	5						5
18	Immediate treatment of remediable defects		5					5
19	Student should respect health habits		4				1	5
20	Sixteen-year age limit			5				5
21	Minimum height of male applicant (5′ 6″)	1				3	1	5
22	Minimum height of female applicant (5′ 2″)	1				3	1	5
23	Present evidence of social adaptability		4	1				5
24	Present evidence of leadership qualities		4	1				5
25	Satisfactory skill in motor activities	1	4					5
26	Present evidence of interest and aptitude	1	4					5
27	Present confidential report of character			5				5
28	Graduation from approved secondary school			5				5
29	Rank in upper two-thirds of class	1				3	1	5
30	Admission by high school aptitude test	2			2	1		5
31	Admission by college entrance examination	1			3	1		5
32	Transcript of high school credits			5				5
33	One semester probationary period			5				5
34	Rank in Junior College in Lower Division					5		5
35	Admission by "C" average Lower Division	1	1			3		5
36	Honorable dismissal from previous college			5				5
37	Official transcript of college credits			5				5
38	No credit with high school deficiencies	3				2		5
39	No college credit for teaching experience					3	2	5
40	Not more than 20 hours in extension			5				5
41	Admission of special students on age				3	2		5
42	Intelligence quotient of 100 or more	2				2	1	5
43	Eighth grade norms in fundamental courses	1				3	1	5
44	Quality (honor) point system for grades				5			5
45	First semester suspension standards					5		5
46	Suspension standards for other semesters				5			5
47	One point practicing teaching eligibility				5			5
48	Graduation standards for quality points				5			5

TABLE III (Cont'd)

1.	2.	3.	4.	5.	6.	7.	8.	9.
49	Inspection of selection standards				5			5
50	Probationary period of one college year	5						5
51	Staff confidential report of each student				5			5
52	Record of extra-curricular activities		5					5
53	Cultural courses for students				3	2		5
54	Present evidence of maturity of judgment		5					5
55	Comprehension examination for practice teaching					2	3	5
56	Comprehension examination for graduation			5				5

REACTIONS TO PROPOSED SELECTION STANDARDS

The data of the selection problem concerning the following standards are presented: (a) acceptable to the training institutions; (b) desirable for admission; (c) desirable for retention in course; (d) recommended as minimum requirements for all institutions; (e) recognized as administrative problems; (f) recommended as optional requirements beyond the minimum; and (g) undesirable and unpractical.

Space was provided in the inquiry form for respondents to record additional suggestions. Twenty additional suggestions were recorded. Only seven of these additions were related to the problem of selection. Three of the seven have been treated in the inquiry form. The other 13 suggestions are not deciding factors in selection. Consult Table II for the data.

FINDINGS, TENDENCIES, AND IMPLICATIONS

Findings—

1. The data presented in Table III reveal the reaction of the panel jury to the 56 suggested measures.

2. A review of the data reveals that institutions or departments desire to formulate definite policies concerning selected applicants.

3. Many criteria are approved for minimum essentials while others are subject to further research.

4. Some standards are favored as optionals.

5. Traditions occasionally prevail over suggested criteria.

6. Selection records should be subject to administrative discretion.

7. Many institutions of higher learning are using orientation courses and probationary periods extending over one full college year in freshman courses to determine previous training of the student.

8. The criteria recommended by the panel jury as minimum selection standards are as follows:

a) Measures dealing with thorough medical examination before and after admission.

b) Unsightly deformities and marked speech defects should be causes for rejection.

c) Minimum age limit of 16 years.

d) Confidential report as to student's character.

e) Graduation from an accredited secondary school.

f) Complete transcript of secondary school credits.

g) One semester probationary period if admitted by scholastic aptitude tests.

h) Honorable dismissal from previous institutions.

i) Official transcript of college credits.

j) Comprehensive examination before graduation.

TENDENCIES

1. The number of ways by which students gain admission and the requirements of a single criterion increase.

2. Institutions are permitting students to follow their intellectual tendencies and are affording vocational guidance.

3. Arbitrary discipline is yielding to individual guidance.

4. In some states, all the higher institutions have adopted selection criteria.

5. Some states are cooperating for state-wide, long-time studies of selection problems.

IMPLICATIONS

1. The multitude of admission methods and of combinations of entrance criteria used by the institutions reveals significantly the fact of no recognized standards of admission. The actual reliability of any individual criterion and of various combinations of criteria needs to be determined.

2. The 48 state departments of education formulate a set of minimum standards in selection.

3. State-owned institutions are not free to adopt many worth-while standards.

4. Private colleges and institutions usually enforce methods of selection more rigidly than do state-owned institutions.

5. Teachers colleges give more attention to selection standards dealing with the personal qualifications of the student.

6. If the emphasis be shifted from entrance to retention standards, the problem of selection will be definitely on its way to solution.

7. The problem is more far-reaching than one of admission qualifications. Careful research studies should be turned to the task of bringing about and continuing the case histories of all candidates with reference to their abilities, habits, characteristics, interests, health, and social attitude.

8. A single criterion is a contributing rather than a critical factor in selection.

A Simplification of the Pulse-Ratio Technique for Rating Physical Efficiency and Present Condition

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AN EXAMINATION of the literature reveals the fact that cardiovascular tests have been designated to measure physical efficiency, endurance, and present condition. In addition they have been used to show the nature of the response of the normal heart to exercise and to discover noncompensated organic lesions. In using the majority of the available cardiovascular tests, one is at once impressed with the fact that many of them require specialized techniques and apparatus as well as considerable time for administration. For the most part, these requirements are disadvantageous, especially when one wishes to use tests where both apparatus and time are limited. In fact, the testing program has suffered considerably because those wishing to use cardiovascular tests have experienced considerable difficulty in fitting them into the program.

It is the purpose of this investigation to take a step forward in the simplification of the cardiovascular testing program. In order to do this the most logical procedure seems to be to begin with a simple, yet reliable, cardiovascular test, and to attempt to simplify it still further.

An investigation of cardiovascular tests revealed the fact that the pulse-ratio test is the simplest to administer and at the same time one of the most reliable. For this reason, it is used as a starting point in this investigation. In order to furnish a setting for the problem, the pulse-ratio test and its uses are discussed.

Definition of the Pulse-Ratio Test.—The test is based on the ability of the heart to compensate for exercise. The pulse-ratio is defined as the ratio of the pulse rate after exercise to the normal sitting pulse rate. It is found by dividing the total pulse for two minutes immediately following a known amount of exercise by the normal sitting pulse for one minute.

Theoretical Considerations.—It has been conclusively demonstrated that the physical condition of an individual has a pronounced effect on both the rate increase due to exercise, and the time required for

the heart to return to normal after the cessation of the exercise. It has also been shown that the individual who is physically trained so that he possesses considerable endurance, will be less affected by a given amount of exercise than one in poorer condition, and those possessing less endurance. It is on the basis of these facts that the pulse-ratio has been proven reliable as a measure of physical efficiency, present condition, and endurance.

The Use of the Pulse Ratio Test as a Measure of Physical Efficiency, Present Condition, and Endurance.—The technique used by those who originated the test has been described by Tuttle and his co-workers[1-7]*. In order to find the physical efficiency of an individual, the amount of standard exercise required to produce a 2.50 pulse ratio is determined. This is an arbitrary figure, adopted solely for purposes of comparison. The 2.50 ratio was adopted because experience showed that in most healthy individuals this figure fell somewhere between ratios resulting from light and strenuous exercise.

The standard exercise employed for the test is stool-stepping because investigation showed that almost any normal individual can do it without much practice. The stool employed was adopted as 13 in. (approximately ⅓ M) high. The exercises used are classified as mild and strenuous.

It is obvious that in order to obtain a ratio figure (2.50) for purposes of comparison it would be practically impossible to fit an exercise to any given ratio. So as to find the exercise (number of stool steps) which is necessary to produce an assumed ratio, the following procedure is employed: a mild exercise, say 20 steps for one minute, is performed. Obviously, this exercise will result in a ratio greater than 2.00 since doubling the normal pulse for one minute results in a 2.00 ratio. Then a more strenuous exercise—for example, 40 steps for one minute—is performed. This will, in most cases, give a pulse ratio greater than 2.50. Now, by plotting the pulse ratios corresponding to both exercises (20 and 40 steps) two points are established and connected by a straight line. This curve furnishes the data for finding the exercise required to produce a 2.50 pulse ratio. The only manipulation required is the dropping of an ordinate from the point where the straight line crosses the 2.50 ordinate, to the abscissa, upon which is plotted exercise in steps. It might be added that if 40 steps fail to produce a pulse-ratio greater than 2.50, a greater number of steps may be performed.

Perhaps a more convenient method for calculation is the substitution of the data in the formula

$$e = \frac{e_2 - e_1}{r_2 - r_1}(r - r_1) + e_1,$$

* Indices refer to Bibliography at end of article.

where e = any desired exercise; e_1 the mild exercise; e_2 the strenuous exercise in number of steps; r_1 the pulse ratio corresponding to e_1; r_2 the pulse ratio corresponding to e_2; and r, the ratio corresponding to e.

Interpretation of the Results of the Test.—The facts which underlie this procedure make the interpretation of the test quite clear. If a group of individuals is given the test and the exercise required of them to produce a 2.50 pulse-ratio is unequal, then they are unequal in physical efficiency and endurance. The results are interpreted as meaning that the individual requiring the least amount of exercise to produce a 2.50 pulse ratio is least efficient while the individual requiring the most exercise to produce this ratio is most efficient.

The Use of the Pulse Ratio Test for Demonstrating the Nature of the Response of the Normal Heart to Exercise.—Until recently[8,9] the response of the heart to exercises of graded intensity had not been demonstrated. The pulse-ratio test was used for this purpose also. The demonstration was carried out as follows: The pulse ratios corresponding to mild and strenuous exercises were experimentally determined for a group of normal people. Then the ratio for some intermediate exercise was determined by the formula

$$r = \frac{r_2 - r_1}{e_2 - e_1}(e - e_1) + r_1.$$

The next step was to have each member of the group actually perform the intermediate exercise selected and experimentally determine the pulse ratio corresponding to the exercise. The results of the investigation showed that in all normal cases, the calculated and experimental ratios were the same within the limits of experimental errors. The conclusion drawn was that the response of the heart varies directly with the strenuousness of the exercise and the relationship is rectilinear. This procedure was applied to grade school children, resulting in the same conclusion.[10]

It might be added that these experiments not only established the heart rate-exercise relationship, but also validated the same procedure as used for determining the amount of exercise required for a 2.50 pulse ratio.

The Use of the Pulse Ratio Test for Detecting Noncompensated Hearts.—The nature of the response of the normal heart to exercises of graded intensity gave a clue to the use of the pulse ratio test for detecting noncompensated hearts. Numerous experiments, validating the test as a means of pointing out noncompensated hearts, have been carried out [11, 12, 13, 14].

That the pulse-ratio test might be useful for finding noncompensated hearts was suggested by postulating the idea that if the response

of the normal heart to exercises of graded intensities was directly proportional to the strenuousness of the exercise and the relationship was rectilinear, the noncompensated heart would not conform to this principle.

The procedure employed was exactly like that used in demonstrating the nature of the response of the normal heart to exercises of graded intensities. The test was given to a group of individuals known to have definite cardiac noncompensations. When the experimental and calculated ratios were compared, it was found that without exception they did not agree, the difference varying directly with the degree of the noncompensation. This being demonstrated, a test was at hand which is reliable for picking out noncompensated hearts. It should be kept in mind, however, that this procedure is only a test for noncompensations, and gives no clue as to the nature of the lesion.

An examination of the pulse-ratio technique at once gives evidence that as it is applied as a test for cardiac function, no further simplification is possible. However, as a test of physical efficiency and endurance, there seems to be a theoretical possibility of reducing the test to yet simpler manipulations. Therefore, it is this question to which attention is now given.

It seems logical reasoning, that if cardiac compensation to exercise is the underlying factor upon which the pulse-ratio test depends, the ratio for a given exercise should be as good an index to physical efficiency, endurance, and present condition as the amount of exercise required to produce an assumed ratio (2.50). It is this particular point which is investigated here.

The Object of the Experiment.—Succinctly stated, it is the object of this experiment to determine if one can rate physical efficiency as well by using the pulse ratio for some standard exercise as by using the amount of exercise required to produce some arbitrarily selected pulse ratio. If this can be done, then the time requirement for giving the test is materially reduced without destroying the validity of the test.

PROCEDURE

In order to test the assumption that the pulse ratio for some standard exercise can be substituted for the amount of work required to produce an assumed pulse ratio, pulse ratios were obtained for 20, 30, and 40 steps of the standard stool-stepping exercises most commonly used where the pulse-ratio test is employed. The individuals tested were ranked as to their physical efficiency on the basis of the pulse ratios obtained. This was done for each exercise used. Following this, the same individuals were ranked again as to their physical efficiency, on the basis of their scores as expressed by the amount of exercise (num-

ber of stool steps) required to produce a 2.50 pulse ratio. Finally, a composite score was calculated for each individual by finding the mean of the ranks as indicated by 20, 30, 40 steps and the number of steps required to produce a 2.50 pulse ratio. By comparing these groups of data one would seem to have a reliable answer to the question set out as the object of the experiment.

THE DATA

Data were collected from a group of 54 normal male subjects. Each individual was subjected to the test for noncompensated organic lesions, and all abnormal cases were discarded. The data collected from the group are shown in Table I. Each subject came to the laboratory and performed the exercises as indicated. A pulse ratio was calculated in the orthodox manner as previously described. For the most part, the data obtained from the three exercises were sufficient for calculating the amount of exercise required to produce a 2.50 pulse ratio. However, in a few cases it was necessary to increase the dosage of exercise beyond 40 steps for one minute.

In order to compare the physical efficiency rankings as indicated by the various dosages of exercise, the ranks for each exercise performed were compared with the ranks as assigned on the basis of the amount of exercise required to produce a 2.50 pulse ratio. In addition, the ranks as indicated by each exercise were correlated with the ranks as shown by every other exercise performed. Finally, the composite score was correlated with the scores obtained from each exercise as well as with the amount of exercise, in terms of stool steps, required to produce a 2.50 pulse ratio. The correlations are shown in Table II. For purposes of identification 20 steps is called exercise 1; 30 steps is designated as exercise 2; 40 steps is labeled exercise 3; the number of steps required for a 2.50 pulse ratio is designated as exercise 0; and the composite score is given as 4.

By referring to the table of correlations it is evident that the physical efficiency scores as indicated by the ratios obtained from 20 steps of exercise correlated rather poorly with the scores obtained by using 30 and 40 steps of exercise. The same is true for physical efficiency as indicated by the amount of exercise required to produce a 2.50 pulse ratio and for the composite score.

On the basis of the correlations it is seen that the physical efficiency ratings obtained by using 40 steps of the standard exercise gives almost the same results as those obtained when the efficiency is found by using the amount of exercise required to produce a 2.50 pulse ratio. Although the correlation between the physical efficiency ratings found by using the pulse ratios for 30 steps and those based on the amount of exercise required to produce a 2.50 pulse ratio is high, it is slightly poorer than

TABLE I

THIS TABLE SHOWS THE PULSE RATIOS AND RANK FOR THE NUMBER OF STOOL STEPS AS INDICATED, THE NUMBER OF STEPS REQUIRED FOR A 2.5 PULSE RATIO AND THE COMPOSITE SCORE*

Case	20 steps		30 steps		40 steps		2.5 ratio steps		composite	
	ratio	rank	ratio	rank	ratio	rank	ratio	rank	score	rank
1	2.10	25.5	2.40	29.5	2.76	34	32	35	31	33
2	2.33	52.5	2.54	44.5	2.70	30	29	43.5	43	42
3	2.07	14.5	2.29	9	2.60	16.5	36	16.5	14	12
4	2.00	1.5	2.26	4.5	2.56	12	38	12.5	10	6.5
5	2.09	21	2.30	7.5	2.55	11	39	10	13	9.5
6	2.17	41.5	2.47	38.5	2.77	35	35	20.5	44	43
7	2.17	41.5	2.36	20.5	2.62	18	36	16.5	24	25
8	2.15	33	2.30	7.5	2.50	8	40	6	14	12
9	Case omitted									
10	2.00	1.5	2.32	15	2.69	28.5	35	20.5	16	14
11	2.03	9	2.40	29.5	2.80	37	32	35	28	29
12	2.07	14.5	2.30	13.5	2.63	19	34	27	18.5	16
13	2.15	33	2.46	37	2.85	42	32	35	47	50
14	2.24	47	2.29	9	2.57	13.5	38	12.5	20.5	19
15	2.02	5.5	2.23	1.5	2.36	1	47	2	2.5	1
16	2.01	3	2.41	32.5	2.88	44	31	39	29.5	30.5
17	2.06	12	2.40	29.5	2.65	22	35	20.5	21	21
18	2.15	33	2.37	23.5	2.59	15	35	20.5	23	23
19	2.33	53.5	2.56	46.5	2.86	43	29	43.5	46	48
20	2.16	38	2.58	48	3.01	50	28	48	46	48
21	2.02	5.5	2.27	6	2.57	13.5	37	14.5	10	6.5
22	2.12	28.5	2.38	25.5	2.67	25.5	34	27	26.5	28
23	2.18	44	2.56	46.5	2.95	46	28	47	46	48
24	2.27	49	2.50	42	2.81	39	28	48	44.5	44
25	2.16	38	2.68	53	3.26	52.5	26	52.5	49	52
26	2.16	38	2.35	18	2.50	8	40	6	17.5	15
27	2.15	33	2.33	16.5	2.50	8	40	6	14	12
28	2.18	44	2.47	38.5	2.74	33	32	35	37.5	36
29	2.18	44	2.54	44.5	2.96	47	29	43.5	45	45
30	2.02	5.5	2.60	50	3.26	52.5	28	49	39	38
31	2.14	30	2.44	35.5	2.66	23.5	33	31.5	30	32
32	2.09	21	2.23	1.5	2.38	2	48	1	6	2.5
33	2.09	21	2.36	20.5	2.68	27	34	27	24	25
34	2.28	50	2.53	43	2.83	41	28	48	45.5	46
35	2.03	9	2.48	40.5	2.90	45	31	39	33.5	35
36	2.03	9	2.36	20.5	2.69	28.5	34	27	21	21
37	2.09	21	2.38	23.5	2.66	23.5	34	27	24	25
38	2.29	51	2.65	51	3.00	49	26	52.5	51	53
39	2.12	28.5	2.39	27	2.64	20.5	35	20.5	21	21
40	2.07	14.5	2.25	3	2.41	3	45	3	6	2.5
41	2.07	14.5	2.38	25.5	2.64	20.5	35	20.5	20	18
42	2.08	17	2.28	7	2.45	5	43	4	8	4
43	2.15	33	2.43	34	2.71	31.5	33	31.5	32.5	34
44	2.09	21	2.59	49	2.98	48	29	43.5	40.5	39
45	2.05	11	2.40	29.5	2.71	31.5	34	27	25	26.5
46	2.02	5.5	2.31	13.5	2.60	16.5	37	14.5	12.5	8
47	2.21	46	2.33	16.5	2.49	6	40	10	19.5	17
48	2.09	21	2.29	9	2.44	4	45	3.5	9.5	5
49	2.10	25.5	2.36	20.5	2.67	25.5	34	27	25	26.5
50	2.25	48	2.48	40.5	2.79	36	31	40	41	40
51	2.16	38	2.44	35.5	2.81	39	31	39	38	37
52	2.09	21	2.41	32.5	2.81	39	32	25	29.5	30.5
53	2.16	38	2.66	52	3.14	51	27	51	48	51
54	2.11	27	2.26	4.5	2.52	10	39	10	13	9.5

* The composite score represents the mean score of the ranks for 20, 30, 40 steps and the number of steps required for a 2.5 pulse ratio.

when 40 steps were used. Obviously, the correlations obtained for ratings based on 30 and 40 steps of exercise would be high. The correlation for the composite scores is lower than for 40 stool steps because of the influence exerted by the poor relationship between the scores obtained by using 20 steps, and the number of steps required to produce a 2.50 pulse ratio.

SUMMARY AND CONCLUSIONS

Data were collected from 54 normal male subjects for the purpose of demonstrating whether physical efficiency can be rated as well by using the pulse ratio obtained after the performance of designated bouts of exercise as by using the amount of exercise required to produce some arbitrarily selected pulse ratio. The bouts of exercise consisted of 20, 30, and 40 standardized stool steps. The physical efficiency ratings obtained from the bouts of exercise were correlated with those resulting from the exercise required for a 2.50 pulse ratio. Also the ratings for each exercise were intercorrelated. In addition a composite score was assigned to each individual and his efficiency rating on this basis was correlated with all other ratings.

On the basis of the data presented, the following conclusions were drawn:

1. Physical efficiency ratings based on the pulse-ratios obtained after 20 stool steps are unreliable.

2. Physical efficiency ratings based on the pulse-ratios obtained after 30 and 40 steps of exercise are as reliable as those obtained on the basis of the amount of exercise required to produce an arbitrarily set pulse ratio.

3. Due to the unreliability of the ratios after 20 steps of exercise, the composite score was less reliable than that obtained after either 30 or 40 steps of exercise.

4. The pulse-ratio technique for measuring physical efficiency may be materially simplified without destroying its reliability.

TABLE II

CORRELATIONS OF THE PHYSICAL EFFICIENCY RATINGS AS INDICATED BY 20, 30, AND 40 STOOL STEPS WITH ONE ANOTHER, WITH THE AMOUNT OF EXERCISE REQUIRED FOR A 2.50 PULSE RATIO AND WITH THE COMPOSITE SCORE*

	1	2	3	4
0	.393	.930	.957	.930
1		.497	.312	.667
2	.497		.926	.954
3	.312	.926		.922
4	.667	.954	.922	

*The method employed for computing the correlations was that of rank differences as expressed by the formula:

$$P_1 = 1 - \frac{6 \Sigma D^2}{N(N^2 - 1)}$$

BIBLIOGRAPHY

1. Tuttle, W. W. "The Use of the Pulse-Ratio Test for Rating Physical Efficiency." RESEARCH QUART. 2 (May 1931) 5–17.

2. Tuttle, W. W. and J. S. Skien. "The Efficiency Rating of High School Boys as shown by the Pulse-Ratio Test." RESEARCH QUART. 1 (Oct. 1930) 19-33.

3. Tuttle, W. W. and Henryetta Frey. "A Study of the Physical Efficiency of College Women as Shown by the Pulse-Ratio Test." RESEARCH QUART. 1 (Dec. 1930) 17-25.

4. Tuttle, W. W. and R. C. Wilkins. "The Application of the Pulse-Ratio Test to Efficiency in Performing on Gymnasium Apparatus. The Horizontal Bar." *Arbeitsphysiol.* 3 (1930) 449-455.

5. Schroeder, E. G. and W. W. Tuttle. "The Application of the Pulse-Ratio Test to Efficiency in Performing on Gymnasium Apparatus. The Parallel Bars." *Arbeitsphysiol.* 4 (1931) 443-453.

6. Scott, Gladys and W. W. Tuttle. "The Periodic Fluctuations in Physical Efficiency during the Menstrual Cycle." RESEARCH QUART. 3 (March 1932) 137-144.

7. Flanagan, Kenneth. "The Pulse-Ratio Test as a Measure of Athletic Endurance in Sprint Running." RESEARCH QUART. 6 (Supp. 2) 46-50.

8. Tuttle, W. W. "The Response of the Heart to Exercises of Graded Intensity." *Proc. Soc. Exper. Biol. and Med.* 28 (1931) 598-599.

9. Tuttle, W. W. "The Response of the Normal Heart to Exercises of Graded Intensity." *Arbeitsphysiol.* 4 (1931) 519-526.

10. Shirley, Mabel J. "Response of the Normal Prepubescent Heart to Exercises of Graded Intensities." RESEARCH QUART. 6 (Oct. 1935) 104-112.

11. Miller, C. I. and W. W. Tuttle. "A Simple Method of Detecting Abnormal Hearts." *Proc. Soc. Exper. Biol. Med.* 30 (Jan. 1933) 414-415.

12. Sievers, Henry. "A Simple Method for Detecting Abnormal Hearts by Use of the Pulse-Ratio Test." RESEARCH QUART. 6 (May 1935) 31-37.

13. Lee, Ethard N. "A Further Study of Tuttle's Test as a Means of Detecting Noncompensated Heart Lesions." RESEARCH QUART. 8 (March 1937) 123-129.

14. Carpenter, Aileen. "Further Observations on Tuttle's Test for Noncompensated Heart Lesions." RESEARCH QUART. 8 (March 1937) 130-132.

Functional Tests: II. The Reliability of the Pulse-Ratio Test

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IT IS difficult to evaluate a test accurately without knowing how reliable it is. Also, as Thurstone demonstrates,[20*] the reliability coefficient is an essential factor in the complete theoretical description of a test; for example, it enters into the calculation of the true validity.

None of the published studies of this test (cf. the entire Bibliography with the exception of reference 20) have been directly concerned with the reliability coefficient, and only a few of them report data that bear on the question at all. One of the original pulse-ratio articles[2] gives a few test-retest data, but the number of subjects is hardly sufficient to justify the calculation of the correlation, and furthermore the results are not given in a form that permits the calculation of scores comparable to those used in the more recent work.[6, 14] Two of the later studies give test-retest scores from which Tuttle's step scores for physical efficiency can be calculated, but in one of them[17] the retest was given after an interval of two months, and furthermore the subjects had abnormal hearts.

In the other study[18] all the subjects had been diagnosed as possibly abnormal, but twenty were finally reported as being normal. The test-retest interval varied between a week and ten days. It is possible to calculate a reliability coefficient from these data, although the subjects cannot be considered as typical normals since they had originally been suspected of having some type of heart lesion. The coefficient turns out to be approximately .61, which is not particularly high. We have also calculated the reliability of the scores for the abnormal and questionable cases, and find that the test-retest correlation is negative but not significantly different from zero.

An approximation of a reliability coefficient can also be calculated from data published by Schroeder and Tuttle[9] in their investigation of physical efficiency in performing on gymnasium apparatus. In their

* Indices refer to Bibliography at end of article.

experiment, the number of maneuvers on the parallel bars that produced a pulse ratio of 2.5 was substituted for the usual stool-climbing exercise; in other respects the technique was standard. Thirty subjects went through each of the five maneuvers they describe. The length of the inter-activity period is not stated. We have calculated the correlation between their exercises 1 and 2, which appear to have been quite similar, and which yield the same mean scores. The coefficient is .53. Between their exercise 1 and 5, which appear to be somewhat different in execution although the averages are identical, the correlation is .64. While the fact that this latter coefficient is the larger argues that the relatively low correlation is probably not the result of specificity in the activity, this possibility cannot be ignored. We have also calculated the inter-correlation from data secured in a similar experiment by Tuttle and Wilkins[8], and find a coefficient of .79 between their exercises A and B, and .71 between their exercises A and E.

Tuttle and Wells[15] have published the pulse ratios of 37 normal subjects who exercised at 18 and 42 steps per minute, then at the rate calculated to produce a 2.5 pulse ratio. Following 15 to 20 minutes of rest they repeated the exercise at the calculated rate. Now, if we use the slope of the line determined by the 18 and 42 step pulse ratios to extrapolate the two experimental pulse ratios that theoretically should have been 2.5, we obtain test-retest step scores. We find the reliability based on these scores to be .90; this is probably higher than it would have been had the complete test been repeated, since we have used the identical slope in both test and retest.

The present report is primarily concerned with two experiments. One involved the testing and retesting of a group of subjects under typical field conditions, the other was made in the laboratory where automatic recording apparatus could be used and experimental conditions controlled more carefully.

FIELD TEST

The test as described by Tuttle[10] was given to 23 normal male subjects, students at San Francisco State College, whose age ranged from 17 to 23 years and whose weight ranged from 135 to 207 pounds. About half of these subjects were athletes (football players), the others were non-athletes. The scores were based on sitting pulse counts in all cases. The experimenter followed Tuttle's instructions closely, and practiced with the test until he had full confidence in his technique. Particular attention was directed towards making sure that the subjects used uniform technique in both test and retest, and that the erect posture was attained each time the stool was mounted. In most cases the subjects were naive.

The easy exercise consisted of climbing the steps twenty times in

one minute, while the harder exercise required forty step climbs in the same length of time. The retest was given after a lapse of about one hour with the exception of three cases in which the test-retest interval was two days. These cases were included in the calculations, since omitting them did not measurably alter the correlation coefficient. One case was reported by the medical examiner to have a "slight heart disturbance" but was not discarded because the test-retest scores agreed even more closely than in the average case.

One case showed a pulse-ratio of 2.6 for the hard exercise on the original test; however on the retest one hour later this exercise resulted in a two minute post-exercise count of only 140, which was the same as the count for the easy exercise. A repetition of the hard exercise gave a count of 144. These counts yield pulse ratios of only 2.12 and 2.14. This subject we have discarded although he was examined and passed by the medical examiner.

Both systolic and diastolic blood pressures were taken on all but one of the subjects and found to be within normal limits with two exceptions, who showed 145/90 and 140/80 respectively. Both of these subjects showed at least average consistency in their test-retest scores.

The reliability coefficient based on the test-retest scores of the 22 cases (calculated by the product-moment method) is .78. The mean physical efficiency, stated as the number of steps of exercise per minute required to produce a pulse ratio of 2.5, is 28.5 for the original test, and 31.4 for the retest. The standard deviation of the combined distribution of the two tests is 7.8.* In the original test, the mean resting pulse rate was 73.4 before the 20 step exercise and 74.4 before the 40 step exercise; for the retest the corresponding rates were 75.3 and 74.9.

LABORATORY TEST

The subjects in this experiment were University of California students, 12 females and 6 males. The ages ranged from 19 to 22 years and the weights from 115 to 198 pounds. None of them were physically "trained." Their physical condition can best be described as "fair." Systolic and diastolic blood pressures were normal for all of these subjects. All had normal hearts at the time of entering the University, and seemed to be normal at the time the test was given with the exception of two females who showed mild symptoms of tachycardia and one male subject whose activities had been restricted by his physician. These subjects showed a test-retest consistency well within the average, so their scores were included in the calculations.

* It has been pointed out by one of the writers[14] that the step scores are of restricted significance as measures of physical efficiency unless the weight of the subject is taken into consideration. Neglect of weight in the present case is intentional, since Tuttle's technique is being followed; this neglect should not, however, have more than a small influence on the magnitude of the reliability coefficient.

Fifteen of the subjects had gone through the pulse-ratio test before the day of the experiment, and all were given preliminary practice immediately upon arriving at the laboratory. The tests were made in the forenoon, beginning usually at 9 A. M., but in a few cases one hour earlier or later. Following the preliminary test, the subject rested in a chair for 45 minutes, and was encouraged either to read or study. At intervals the pulse rate was taken, and if progressive deceleration was observed near the end of the rest period, it was prolonged. Next, instructions were given to relax as completely as possible. In the case of six of the subjects, this was done in the standing position with one arm and part of the individual's weight supported on a chair, and all pulse counts were made standing. Sitting counts were uniformly employed for the remainder of the subjects.

Following ten minutes of relaxation, the resting pulse rate was secured. The subject stood quietly in front of the stool for three minutes and then exercised for one minute at the rate of 18 steps per minute in cadence with a metronome. The sitting position was resumed (except as noted above) and the post exercise count was taken. Twelve minutes of rest were allowed, then the subject rose and three minutes later began the harder exercise. This consisted of 30 steps in one minute for the female subjects, and 40 for the males. During the exercise, verbal encouragement was given when necessary in order to insure the maintenance of the prescribed rate. The post-exercise pulse rate was taken as before. At its conclusion the subject rested for 45 minutes as at the beginning of the test, and then proceeded through the retest. One of the subjects did the two easy exercises first; in this case the long rest was interposed between the two 30-step exercises.

The pulse beats were automatically recorded by a sphygmograph. Electric contacts on the stool operated a pen which indicated each climbing of the stool on the same record. Another pen recorded time in seconds. With this technique it was possible to eliminate counting errors, and in addition the post-exercise count could be started with temporal uniformity for all subjects since the record showed just when the subject completed the last mounting of the stool.

The reliability coefficient calculated from the data obtained in this experiment is .84. The mean physical efficiency, in step scores, is 33.5 for the test, and 34.0 for the retest. The standard deviation is 9.5. The mean resting pulse was 72.2 beats per minute before the test, and 72.3 before the retest. These pulse rates are remarkably low, taking the various factors into consideration, and indicate that adequate rest was given the subjects.

DISCUSSION

The two experiments were conducted independently. The experimenters had no knowledge of each other's findings until after the data

had been secured. The subjects were males in one experiment, and about half were athletes in very good condition; in the other all were non-athletes and two-thirds were females. The techniques were somewhat different. Nevertheless, the reliability coefficients of .78 and .84 are very similar in magnitude, particularly when the difference in variability of the two samples is taken into consideration. For this reason, we feel that the coefficient of .82 that is obtained for the combined experiments (totaling 40 subjects) is probably representative of the test, when the step scores are used as measures of physical efficiency.

It should be pointed out that the subjects in the field experiment showed a higher efficiency on the retest. The difference is statistically reliable, as it is 3.9 times its probable error. Since the subjects were naive, the improvement is probably due to practice. However, it is doubtful if this increase affected the correlation very much since inspection of the data reveals that it was fairly evenly distributed among the subjects. No practice effect was observed in the laboratory experiment. The women showed on the average a greater step efficiency than the men, but when the scores are recalculated and based on an equal number of foot-pounds of work done (by taking into account the subject's weight) this is no longer true. The average of all our physical efficiencies is 31.85 steps; this is almost identical with the mean value of 32 that we have calculated from Tuttle and Wells' 37 subjects.[15]

The reasons for believing that the reliability of .90 which we calculated from Tuttle and Well's data is too high have already been mentioned, as have the reasons for believing that the coefficients of .53 and .64 based on Schroeder and Tuttle's results, those of .79 and .71 that we calculated from Tuttle and Wilkins' data, and the correlation of .61 we computed between the test-retest scores of Lee's normal cases, are too low. Our reliability coefficient of .82 is somewhat lower than the highest of these listed above; the difference could however be due to sampling error since it is found to be slightly less than two times its probable error.

The results can best be interpreted by pointing out that a reliability of .82 means that the predictive index of the test in determining scores on the test itself (which is comparable to per cent of maximum predictive efficiency) is only .43; for a reliability of .90 the index is .56, and rises rapidly as the correlation approaches unity. Obviously, any test will be more efficient in predicting itself than in predicting scores in something else, as for example athletic performance or physical condition.

Another point of view may be gained by considering the theoretical limitations of an observed correlation between the test and some typical athletic performance. A reliability of .92 has been reported for the quarter mile run. Let us assume that the *true* correlation between

athletic performance in the run and physical efficiency as measured by the cardiac test (i.e. the *true* validity) is .90—we could hardly expect it to be much higher since cardiac efficiency is by no means the sole determiner of athletic performance. The observed correlation between the run and the test can theoretically never exceed the product of the *true* correlation and the geometric mean of the reliability coefficients of the run and test. Now, if the test reliability is .82, the observed correlation should not exceed .78; if the reliability is .90 it should not exceed .82. Assuming the rather high value of .95 for the *true* validity coefficient, the observed values would be about .83 and .87.

Clearly the reliability coefficient of a test is crucially significant. The reliabilities of the physical efficiency scores based on the pulse-ratio test that have been reported in this paper are not as high as is desirable if the test is to be used for individual prediction. An analysis of the reliability of various aspects of cardiac function with a view towards determining physiological and other limitations, and increasing the reliability of the test, will form the subject matter of another report.

SUMMARY AND CONCLUSIONS

Approximations of the reliability coefficient of the pulse-ratio test used as a measure of physical efficiency were calculated from published data on the test. These coefficients were found to range from .53 to .90.

Two experiments on test-retest reliability were made. The first, based on 22 subjects tested under field conditions, determined the reliability coefficient as .78. In the second, the reliability of the scores of 18 subjects tested under laboratory conditions was found to be .84. The reliability of the scores of the combined group of 40 subjects was .82.

A brief discussion of these results, in connection with theoretical considerations, led to the conclusion that the test in its present form is not as reliable as is desirable if it is to be used for predicting individual scores.

BIBLIOGRAPHY

For the purpose of tracing the development of the pulse-ratio test, the references are arranged in groups, and are listed in chronological order within the groups.

I

Hunt's Pulse-Ratio Test

1. Hunt, G. H. and M. S. Pembrey, "Tests for Physical Efficiency: I." *Guy's Hosp. Rep.* 71 (1921) 415-28.

2. Hambly, W. D., G. H. Hunt, L. E. L. Parker, M. S. Pembrey, and E. C. Warner, "Tests for Physical Efficiency: II." *Guy's Hosp. Rep.* 72 (1922) 367-85.

3. Campbell, J. M. H., "Weight, Vital Capacity, Pulse Rate before and after Exercise, and Physical Fitness in Health." *Guy's Hosp. Rep.* 75 (1925) 263-85.

4. Hambly, W. D., M. S. Pembrey, and E. C. Warner, "The Physical Fitness of Men Assessed by Various Methods." *Guy's Hosp. Rep.* 75 (1925) 388-94.

5. Campbell, J. M. H., "The Pulse Rate after Exercise in Health and in Heart Disease." *Guy's Hosp. Rep.* 77 (1927) 184-215.

II

Use of the Test in Physical Education

6. Tuttle, W. W. and J. S. Skien, "The Efficiency Rating of High School Boys as Shown by the Pulse-Ratio Test." RES. QUART. 1 (Oct. 1930) 19-33.

7. Tuttle, W. W. and H. Frey, "A Study of the Physical Efficiency of College Women as Shown by the Pulse-Ratio Test." RES. QUART. I (Dec. 1930) 17-25.

8. Tuttle, W. W. and R. C. Wilkins, "The Application of the Pulse-Ratio Test to Efficiency in Performing on Gymnasium Apparatus. The Parallel Bars." *Arbeitsphys.* 4 (1931) 443-52.

9. Schroeder, E. G. and W. W. Tuttle, "The Application of the Pulse-Ratio Test to Efficiency in Performing on Gymnasium Apparatus. The Parallel Bars." *Arbeitsphys.* 4 (1931) 443-52.

10. Tuttle, W. W., "The Use of the Pulse-Ratio Test for Rating Physical Efficiency." RES. QUART. 2 (May 1931) 5-17.

11. Scott, G. and W. W. Tuttle, "The Periodic Fluctuation in Physical Efficiency during the Menstrual Cycle." RES. QUART. 3 (Mar. 1932) 137-44.

12. Shirley, M. J., "Response of the Normal Prepubescent Heart to Exercises of Graded Intensities." RES. QUART. 6 (Oct. 1935) 104-12.

13. Flanagan, K., "The Pulse-Ratio Test as a Measure of Endurance in Sprint Running." RES. QUART. SUPPL. 6 (Oct. 1935) 46-50.

14. Henry, F. M. and F. L. Kleeberger, "The Validity of the Pulse-Ratio Test of Cardiac Efficiency." RES. QUART. 9 (March 1938) 37-46.

III

Tuttle's Method of Detecting Abnormal Hearts

15. Tuttle, W. W. and G. Wells, "The Response of the Normal Heart to Exercise of Graded Intensity." *Arbeitsphys.* 4 (1931) 519-26.

16. Miller, C. I. and W. W. Tuttle, "A Simple Method for Detecting Abnormal Hearts." *Proc. Soc. Exp. Biol. and Med.* 30 (1933) 414-15.

17. Sievers, H., " A Simple Method for Detecting Abnormal Hearts by the Use of the Pulse-Ratio Test." RES. QUART. 6 (May 1935) 31-8.

18. Lee, E. N., "A Further Study of Tuttle's Test as a Means of Detecting Non-compensated Organic Heart Lesions." RES. QUART. 8 (Mar. 1937) 123-9.

19. Carpenter, A. "Further Observations on Tuttle's Test for Non-compensated Heart Lesions." RES. QUART. 8 (Mar. 1937) 130-2.

IV

20. Thurstone, L. L., *The Reliability and Validity of Tests.* (Ann Arbor, Mich.: Edwards Bros., 1931).

Physical Education at Amherst

The Impetus for Introducing Physical Education into the Educational Curriculum

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TO STUDY the development of physical education at Amherst College is to become acquainted with the first department of this kind to be established, recognized, and enforced as a part of the curriculum in an American educational institution. It can be said safely that the establishment and success of physical education at Amherst acted as an impetus to the building up of similar departments in schools and colleges throughout the country, until today when it has become a part of the normal educational curriculum. Who backed this idea, what was included in it, and by whom and how it was carried out is a story full of interest to the modern educator.

It is to one of her own presidents that Amherst owes the first important steps taken toward the establishment of a physical education department. In his inaugural address in 1854, as quoted in an article by Dr. Nathan Allen, President Stearns maintains that "no course of education is complete without devoting special attention to secure a good development and healthy state of the physical system."[1] This subject is mentioned repeatedly in his reports to the trustees for the next few years. In 1855 he states, "no one thing has demanded more of my anxious attention than the health of the students. The waning of physical energies in midway of the College course is the rule rather than the exception."[2] He suggests in 1856 that they have some distinguished medical men come to give lectures to the students on the laws of health. And in 1859 with the deaths of two of the student body on the college record, health again constitutes a large part of the president's report. It is at this time that he submits a plan for the introduction of a gymnasium into the college life as a means of preventing poor health.

If a moderate amount of physical exercise could be secured as a general thing to every student daily, I have a deep conviction, founded on close observation and experience, that not only would lives and health be preserved, but animation and cheerfulness, and a higher order of efficient study and

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[1] Nathan Allen, M.D. "Physical Culture in Amherst College," p. 3; Amherst College—*Physical Culture*, Vol. I; (Lowell, Mass.: Stone and Huse Book Printers, 1869).
[2] *Ibid.*, p. 3.

intellectual life would be secured. It will be for the consideration of this Board, whether, for the encouragement of this sort of exercise, the time has not come, when efficient measures should be taken for the erection of a gymnasium and the procuring of its proper appointments. It is a settled conviction in my own mind, that only by a certain amount of regular exercise, together with attention to other laws of health, can that listlessness and dullness and inefficiency which is hostile to good scholarship and so common among students be overcome.[3]

Following this report, immediate action was taken in the building of a two-story gymnasium, fifty feet by seventy-two feet, named the Barrett Gymnasium in honor of the generous donor, Dr. Benjamin Barrett of Northampton. Since this Department of Hygiene and Physical Education was new, it was felt that the teacher of the Department might need advice and direction, and consequently a Gymnasium Committee was elected by the Board of Trustees, consisting of President Stearns and Doctors Alden and Allen. The decision of this committee was that the new department should be run after the following plan:

1. The main object is not to secure feats of agility and strength, or even powerful muscle, but to keep in good health the whole body.

2. All students shall be required to attend on its exercises for half an hour, designated for that purpose at least four days in the week.

3. The instructor shall assign to each individual such exercise as may be best adapted to him . . . endeavoring to work the whole body and not overwork any part of it.

4. While it may not be expedient to mark graduation of attainment as in intellectual branches, yet regularity, attention, and docility should be carefully noted so as to have its proper weight in the deportment column of the student's general position.

5. Some time shall be allowed out of study hours for those volunteer exercises which different men, according to their tastes may elect for recreation . . . all these voluntary exercises . . . to be conducted under supervision of the Gymnasium instructor.

7. The instructor ought to be a member of the Faculty, and give in to it his marks and occasional accounts, and receive directions, as other officers of the college are accustomed to. It must be obvious from this general view, that a teacher of high qualifications will be demanded . . . We should not only have the honor of being the first institution in the country which has ever sustained such a professorship, but we should probably save to the world a vast amount of physical and mental power which would otherwise be wasted, and further the great ends of education, which are *to make men*.[4]

From this original plan it is clear that the intention of the college was to make the exercises a part of the regular curriculum and to require the students to attend them as much as any of their other classes.

[3] *Op. cit.*, pp. 4-5.
[4] *Ibid.*, pp. 7-8.

In order to place the enterprise in a position which its importance and success demanded, the Trustees decided that two things were indispensable: "first—the living teacher—one thoroughly acquainted with the structure and functions of the body, with a knowledge of the laws of hygiene; and secondly this physical training must be made part of the regular exercises of the Institution, and must be stamped with the same importance, authority, rewards, and sanctions as are accorded to the other branches of study."[5] Because of this feature, Amherst College takes the lead in the history of physical culture as connected with large educational institutions. To quote Dr. Allen, "it is the first instance in the whole history of modern education where the claims of the body, its proper development and health training, have been based on the same platform, and the same importance attached to them as to any other branch of study or mental acquirement."[6]

Thus the story unfolds of how physical education became placed on the same basis with other departments in an American college. It was given its proper place of importance for the first time at Amherst College, but it was by no means an immediate thing that its place in the field of education was recognized generally. Not until it had been carried on there for several years with a great degree of success did it catch the attention of other schools and colleges as a new and necessary part of their curriculum. However, Amherst was by no means so slow in seeing the favorable results which came from its experiment. Not only was there marked improvement in the general physique of the students, but there was actually less sickness in the college, and, still more important from an educational viewpoint, the whole standard of scholarship was raised, according to the records of the registrar.

Before going on to relate the development of this department and how the plans laid out by the Trustees and the Committee were carried out to the advantage and honor of the college through the leading personality of the splendid professor appointed, it is of particular interest to read the description of the type of exercises which the students were given. It must be remembered that the development and health of the whole body was the main object stressed by the college, so it was toward this objective that the exercises aimed.

Each class has a uniform of its own, and forming together in a line, in the lower room, marches in regular order into the upper hall under its respective captain, frequently singing a lively song. The roll is then called by the Professor, absences and deportment marked; the members of the class then dividing into sections and obtaining their dumbbells, Indian clubs or wands, take their places in the central portions of the hall, where they go through with an almost endless variety of evolutions, assuming every position of the legs, arms, and body possible . . . The lighter gymnastics as

[5] *Op. cit.*, p. 10.
[6] *Ibid.*, pp. 10-11.

here practiced are undoubtedly best adapted to effect the object intended. It is surprising what a great number and variety of exercises are here devised and practiced, amounting in the course of the year to some five hundred. The design is, that all the muscles of the body should be exercised in a manner to equalize best the circulation of the blood, to expand the lungs, to aid the stomach in the digestion of food, and to strengthen the joints—to develop all parts of the body in harmony with the most efficient action of the brain.[7]

The last part of the statement above brings up the keynote which links physical education with education. It is this fact that there is an intimate and necessary connection between the growth of mind and body which is so essential to be recognized. And this point Amherst saw clearly as is shown in Dr. Allen's concluding remark: "When the inter-dependent relations of body and mind are considered in their true light . . . it is scarcely possible to overstate or overestimate the importance of physical culture."

No matter how carefully a plan may be conceived, a certain amount of responsibility still rests on the shoulders of the person put in charge as to the success with which it is carried out. In 1860, the first year for the trial of this new experiment, the department was in the hands of an extremely able and well educated man, Dr. Hooker. But due to his age and lack of strength, he was unable to carry on for more than a year. His place was taken by Dr. Edward Hitchcock who remained head of the department for fifty years, from 1861 to 1911, and under whose wise and careful guidance this new child of education grew and flourished.

From the outset, Dr. Hitchcock saw and emphasized the important connection between the mind and the body. Again and again in his annual reports to the Trustees and in various lectures which he gave outside of the college, he stresses this particular point, thus adding strength to its educational value. In a paper at a meeting of the Social Science Association in Saratoga, New York, 1869, he says: "The modern idea is to recognize, control, and direct physical culture, recreation, and amusements as a part of our educational system, in order to make use of all the energy of the student while in college or school."[8] Energy, therefore, he refers to as being both mental and physical. Again in an article entitled "Physical Training in College" he states that, "The attention given to the health of body and mind among educational institutions is one of the marked features of modern progress." However, he goes on to lament that, "Like music and some other branches of education, physical culture has been appended to and recommended by many educational institutions, but in only a very few up to the present time has it been made a vital part of the

[7] *Op. cit.*, pp. 14-16.

[8] Amherst College—Physical Culture, Vol. I, from newspaper clipping, The Republican.

regular course of culture." Later, in 1879, in an article entitled "Physical Education and Hygiene in Amherst College," he writes once more on the same subject: "The fact is forgotten, that when both body and mind are in a healthy condition they are like sworn friends to each other, but when not in harmonious cooperation . . . they are like bitter enemies acting towards one another with the most destructive malignity." In summing up Dr. Hitchcock's opinion of the educational value of this department, another quotation is taken from this same article: "Even if its methods of management may not be such as can be used in other branches of educational work, yet it is certainly valuable to the student if by it he is able to maintain more than an average degree of health and work."

Although innumerable similar quotations could be given showing the influence which Professor Hitchcock had in spreading this doctrine of the educational importance of physical culture as exemplified by the link between mind and body, this is only one way in which he made obvious the advantages of requiring such a department in all schools and colleges. What he is most famous for along this line is the work which he did in his so-called "vital statistics." In an address by Dr. G. A. Leland he mentions: " . . . it can be said without fear of contradiction that the science of anthropometry here first became systematically developed."[9] By following up his annual reports to the Trustees, one reads the step by step development of this work.

In his first report to the Trustees, written in June, 1862, Dr. Hitchcock explains exactly what he means by "vital statistics" and what he hopes to accomplish by them. "By this I mean that I record his age, weight, height, size of chest, arm and forearm, capacity of lungs, and some measure of muscular strength, and post them in the Gymnasium. If these statistics are continued for a series of years, they will be invaluable not only for physiological science, but also to enable us to determine how far the Physical Department is of service to the College. In the past year the statistics have shown decided increase in all particulars."[10] By putting such emphasis on anthropometrics, Professor Hitchcock immediately placed his department on a scientific as well as a practical basis. Naturally his early reports have too little material before them for him to make any particularly outstanding comparisons. But his twentieth annual report shows the end toward which he is working.

> One of the first duties I felt called upon to perform after your appointment to this Professorship, was to prepare blanks for several anthropometric observations of the students of college. This I did partly to enable the students to learn by yearly comparison of themselves how they were getting on as regards the physical man. The ulterior object, however, was to help

[9] MSS. in Archives.
[10] *Ibid.*

ascertain what are the data or constants of the typical man, and especially the college man. I have conceived no theory on the subject, and have instituted but very few generalizations; but my desire has been to compile carefully and put on record as many of these observations for comparison and verification of statistical work in this same direction by many other persons in America and Europe.[11]

By this time his system of taking measurements has greatly enlarged and includes fifty-nine other items added to the original nine, besides "the ancestral history and lineaments, the present condition of the most important vital organs, and a test of the power of essential parts of the body of each student." It is always his intention that the results of this test will be used by the student to tell him his weak as well as his strong points, so that he may improve the weak by the assistance of the Professor's directions and the apparatus of the college. And again in this work he brings up the old and important item of the association of mind and body.

Another important and interesting value attached to this anthropometric work is to ascertain the effect of four years' study upon the individual. Whether the common remark that mental development is often at the expense of physical, is borne out by facts, and if such is the case to find a remedy: that men leaving college with good mental endowments may have them fortified by a uniformly developed physique. This is a question which we may help to settle by a long and careful series of observations.[12]

Just as his articles and lectures on the mind and body could not help attracting the attention of the alert educator, this new work in anthropometry was gradually brought before the eye of the public, bringing excellent publicity to the college, and much honor to the labors of the painstaking Doctor. A comment in his twenty-fifth annual report mentions the sensation his work is creating: "Our anthropometric work is just now exciting as much interest among educators, and eliciting more letters and talk than did the creation of the Department by yourselves 25 years ago."[13] And again in his report of 1888, it is shown that the results of his observations have been noted abroad as well as at home. He casually mentions having received a note from Mr. Francis Galton of London congratulating him on his work, and advising him to undertake some collateral work of an anthropometric nature.

Aside from his educative and scientific work, Dr. Hitchcock was continually working for the sanitary improvements both of the college dormitories and the gymnasium. As the college increased in size and the equipment grew old, he urged the building of a larger and more modern gymnasium. His pleas were finally heard and answered with a generous offer from one of the alumni, Mr. F. B. Pratt. Plans were set down in 1893, and by 1895 the building was complete and in run-

[11] *Op. cit.*
[12] *Ibid.*
[13] *Ibid.*

ning order. The two points which the Doctor particularly stressed as a definite necessity for the improvement of sanitation were the addition of water closets and baths to the plans. These conveniences which today are taken for granted were then looked upon as sensational novelties, and brought forth much comment as exemplified by an article in *Harper's Weekly*. The description reads as follows:

> In the basement are two large rooms each 78 feet by 20, and 18 feet in the clear, the one for ball and winter tennis, the other for bowling alleys, while the rest of this floor is taken up with the sparring-room, the rowing-room, the space for large dumbbells, clubs, lavatory, closets, and bathrooms; the latter having six full-length tubs and six sponge tubs . . . On the right, as you enter the main or west door, you come upon a large dressing-room with some three hundred lockers. From here the student may pass in undress directly into a showerbath room lined with encaustic tiles, where four shower baths, a side bath, and douche, with water at any desired temperature, combine to make bathing a luxury.[14]

The article goes on to eulogize the building of such a gymnasium and to encourage similar ones being constructed in other colleges in the country by well-to-do alumni. It shows at once that the importance of physical education and its place in educational institutions is gradually getting a firm foothold in the minds of the American public. The conclusion of the article aptly foretells what strides this new department will take in the next few years, and the general fine results that will come from it.

> If the body of each student, not only at Amherst, but at every seat of learning in this land, could be put and kept in such shape, would not the gain in efficiency among the men who are to hold the places of trust and wide influence be incalculable? The demand that the colleges, besides otherwise giving the student his fittest training mentally, should put and keep his body in the best shape for effective and sustained mental labor, is already heard in many parts of the land. The race among colleges to meet that demand has already begun—a race in which prodigious strides will be taken in the next ten years. And that college will win which first finds the maximum of bodily strength and endurance consistent with the highest mental labor, and then insures that maximum to every student as he graduates.[15]

Certainly, on reading this, the Doctor must have felt that his point had at last been recognized and carried.

Always in advance of his contemporaries in the field, Professor Hitchcock was among the first to accept and see the worth-while and educative side of recreation and sports. Even in his earliest report he admits encouraging "playful exercises such as running in grotesque attitudes, singing College songs, etc." His reason for permitting this

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[14] William Blaikie, "The Pratt Gymnasium at Amherst," *Harper's Weekly*, Feb. 21, 1895.

[15] *Op. cit.*

is that "it seems desirable to me that a portion of the animal spirits should be worked off inside the stone walls of the Gymnasium, under the eye of a College officer, rather than out of doors, rendering night hideous."[16] However, it is not until 1887 that he takes any definite steps toward the organization of sports as a substitute for regular gymnastics and at first there are definite restrictions.

> The only remark I would make about the general plan of physical exercises is that I am able to give a little greater variety to the students by allowing a change in the form of exercise day by day to the few who desire it. In other words, in pleasant weather, summer and winter, a student may secure by an excuse obtained *only for the day*, permission to take his exercise at tennis, baseball, or on horseback, or sawing wood instead of the class exercise in the gymnasium.[17]

The increased interest and enthusiasm in Amherst athletics is marked by the gift to the college in 1889 of a new athletic field presented by Mr. F. B. Pratt which only added to the general stimulation in this direction. But it is in an article published in the *Outlook,* May, 1895, that Hitchcock at last states the position which athletics rightfully claim and will soon obtain through public popular demand.

> . . . In the last few years have grown up the athletic sports which demand the field, the air, varied temperatures, sunshine, and the test of strength, skill, and sport between man and man. The races and competitions for speed and time, the feats, the sports, the capabilities of quickness and strength, go back for their origin as accepted necessities to Greek and Roman times. And they have come in again to stay . . . The demand of the public for better health, public and individual, more bodily vigor and power, is on us and surely it is for us to recognize it in the Athletic Age.

He is careful to distinguish between the Athletic Age and the Gymnastic Era which is his title for the regular formal gymnastics which he himself had been influential in building up in the previous thirty years. He goes on to state that these will continue to stay for the great masses giving them a regular and normal development of the body but that "this very fundamental work demands a broader and higher growth of physical prowess," which can be expressed in the Athletic Age in "the necessary spectacular exhibitions without brutality, coarseness, unfairness, or indelicacy even." His conclusion is that "the Gymnastic Era has done its work; now let the Era of Athletics come in and benefit us as much in the next ten or twenty years as the Gymnastic Era has in the past."

It is hardly to be wondered at that the alumni of Amherst College should want to show their appreciation and gratitude to "Old Doc"

[16] MSS. in Archives, first annual report to Trustees.
[17] MSS. in Archives, twenty-seventh annual report to Trustees.

Hitchcock (as he became affectionately called) for the tremendous amount of work he put into the building up of the physical education department, making it successfully carry out the objectives first set down by President Stearns and the presiding Trustees. They determined to present him with a loving cup at the graduation exercises in 1899, which was also the year of his fiftieth reunion. Dr. G. A. Leland was appointed to make the presentation speech, and in this he mentions various instances when the work of the Professor has brought honor to the door of his Alma Mater. Among the most outstanding are two instances when through his work, Amherst was given international attention. In the early seventies, the Amherst compulsory system of gymnastics caught the eye of Mr. Tanaka Fujimaro, acting minister of education in Japan, and in 1878 President Seelye received a request to send someone to Japan who could establish the Amherst system of physical training in their schools.

> As a result, within a year, a facsimile of the Barrett Gymnasium, at least as to internal arrangement and apparatus, was erected in Tokio and put into almost daily use: and within 3 years, 120 young men had been trained to teach the Amherst system together with its principles as based on the sciences of anatomy, physiology, and hygiene, and 6 or more schools . . . reaching nearly 3,000, both male and female, had been brought under the beneficent influence of regular compulsory exercises.[18]

Certainly it was an honor to Amherst that out of all the institutions in the United States and Europe her system should be chosen as a model, and certainly the success of the system falls in turn on the shoulders of Professor Hitchcock.

The second instance of honor paid by another country to Amherst was a letter from Professor Müller of Berlin, an eminent authority, to Dr. Hitchcock asking what is being done in the physical education of students in the United States. "This letter was sent not to the older and greater institutions of Harvard and Yale but to Amherst College by advice of our Ambassador to the German Government, Dr. A. D. White, who evidently knew where the best information was to be found."[19]

With the outstandingly farsighted plan which established the department of physical education in Amherst, and with the outstandingly farsighted personality of Dr. Edward Hitchcock to carry out this original plan, it is not surprising and it can certainly not be contested that Amherst provided the impetus for other educational institutions to follow its splendid example in this important department of education which cares for the body as well as the intellect.

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[18] MSS. in Archives.
[19] *Ibid.*

BIBLIOGRAPHY

1. Amherst College Memorabilia
*Department of Hygiene and Physical Education**
Vol. I 1859-82
Vol. II 1883-1891
Vol. IV 1900-1907

2. Amherst College Memorabilia
*Department of Physical Education**
Clipping and Extracts 1862-84

3. *Physical Education and Hygiene in Amherst College For 25 Years.**

4. *Physical Education and Hygiene in Amherst College For 13* Years.*

5. *Amherst College—Physical Culture** (Lowell, Mass.: Stone and Huse Book Printers, 1869); Vol. I, II, III.

6. Annual Reports to Trustees of Amherst by Edward Hitchcock in Manuscript Form.

7. Loving Cup Presentation Speech by G. A. Leland in Manuscript Form.

8. Hitchcock, Edward M. D., "The Gymnastic Era and the Athletic Era of Our Country," *The Outlook* (May, 1895).

9. Blaikie, William, "The Pratt Gymnasium at Amherst," *Harper's Weekly* (Feb. 21, 1895).

* These volumes include collections of reports, clippings, articles, programs, anthropometric tables and various other things of interest which help to piece together the history of the Department. Most of them have not been put together by any one publisher or have any page numbers to refer to, they are simply material gathered mainly by Professor Hitchcock himself. I skimmed through them all looking for the most interesting material.

A Study of the Relationship of Dominance to the Performance of Physical Education Activities

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THE conventional classification of individuals into right-handed and left-handed groups provides very little information regarding their manual habits. Yet detailed information concerning the way in which the hands and feet are used may have considerable practical importance, particularly in the field of physical education.

When acts of skill in physical education activities are performed, usually preference is given to one side of the body. The accepted procedure is to permit one to use the side of the body which seems natural. However, social customs and methods of teaching have established the idea that right-sided performance is to be preferred. It should follow then that social customs and methods of teaching in physical education have been determining factors in establishing which side of the body shall dominate in many acts of skill.

The implications of dominance in relation to the performance of acts of skill in physical education are far-reaching. It is reasonable to suppose that many children are socially right dominant yet physiologically ambidextrous. Perhaps many of such a group should have been trained socially left dominant instead of right to obtain the best results in performing acts of skill. Or, perhaps they should be encouraged to retain their ambidexterity in performing certain skills. The retention of ambidexterity in performing manual acts has been noted among boys although there is insufficient information on the subject to explain its existence.

A study of the literature reveals the fact that there are at least two types of dominance being considered. One is a social dominance which is usually conditioned; and the other is what might be termed physiological dominance, which deals largely with the preferential choice for manual acts aside from social conditioning and the order of response when two members of the body respond to the same stimulus. In this study social dominance has been considered only

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insofar as it is necessary for purposes of checking results and making comparisons.

The purpose of this investigation is to study certain fundamentals pertinent to an understanding of dominance of the upper and lower extremities and its relation to the performance of physical education activities. The order of response when two members of the body respond to the same stimulus by simple flexion movements was used as a measure of dominance. The approach to the problem requires primarily a study of native or inherent unilateral organization although it is necessary to study actual performance for purposes of comparison.

The specific points to be considered are:

1. The measurement of handedness and footedness of boys of varying age groups as shown by the order of response.

2. The measurement of dominance as exhibited through actual performance of physical education activities.

3. A determination of the relationship of dominance to the performance of physical education activities as shown by a comparison of actual performance with the order of response.

REVIEW OF THE LITERATURE

Reports on various phases of social dominance are abundant. Comparatively few studies are available pertaining to physiological dominance and especially is this true with respect to its relationship to the field of physical education. A few studies of physiological arm dominance are particularly valuable. However, with regard to physiological foot dominance there is practically no information. For that reason the part of this study dealing with dominance of the lower extremities necessarily will be larger exploratory.

Travis and Herren,[1] in a study of simultaneous antitropic movements of the hands of stutterers, attempted to determine whether both hands start to move at exactly the same instant when the subject attempts to move them at the same time but in opposite directions. The results of this experiment indicated that right-handed subjects lead more frequently with the left hand while left-handed subjects lead more frequently with the right hand. No significant difference seemed to be found between the groups, relative to simultaneous leads. The explanation set forth for this behavior is that the attention was focused on the non-dominant member, thus causing it to lead the movement.

Metfessel and Warren[2] studied action-currents in simultaneous

[1] L. E. Travis and R. Y. Herren, "Studies in Stuttering, V. A Study of Simultaneous Antitropic Movements of the Hands of Stutterers." *Archives of Neurology and Psychiatry*, 22, (1929) pp. 478-494.

[2] Milton Metfessel and Neil D. Warren, "Overcompensation by the Non-Preferred Hand in an Action Current Study of the Simultaneous Movements of the Fingers." *Journal of Experimental Psychology*, 17 (1934) pp. 246-256.

movements of the fingers. The results showed that, as a whole, there was a definite tendency for both action-current leads and movement leads to favor the hand not used in writing, probably due to overcompensation of the less used hand in an attempt at simultaneous movement. Orton and Travis [3] in studying action-currents in stutterers and normal speakers found that in the right-handed normal speakers during the simultaneous flexion of the digits of the two hands action-currents tended to arrive first in the right forearm of a majority of the subjects.

In a study of the relation of precedence of movement in homologous structures to handedness, Tuttle and Travis [4] attempted to measure native or inherent unilateral organization and to determine its relationship to ordinary expressions of unilateral choice. Three experimental groups were set up in order to test the influence on lead preference of instructions and the task involved in responding. A right-handed, a left-handed, and an ambidextrous group were selected for study by use of a laterality index.

It was concluded that the precedence of lead in simultaneous contraction of homologous muscle groups is determined largely by instructions given and the task involved.

Vogel [5] studied the relationship of dominance to acts of skill by employing the same technique used by Tuttle and Travis.[6] The acts of skill measured were batting and throwing a baseball. Twenty members of a varsity baseball team were employed as subjects.

The conclusions were that physiologically right dominant individuals both throw and bat right-handed. The physiologically left dominant individuals show a mixed behavior in performing the acts of batting and throwing although the majority of them show right-handed response. The physiologically left-handed individuals show right-handed performance.

Analysis of the studies reported pertaining to the measurement of the order of response of the arms shows that there has been difficulty in securing responses of the arms apart from attentional control. The results obtained by Tuttle and Travis seem to indicate that when a more complicated stimulus is used movements of the arms are relatively free from attentional control.

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[3] Samuel T. Orton and L. E. Travis, "Studies in Stuttering. IV. Studies of Action Currents in Stutterers," *Archives of Neurology and Psychiatry*, 21, (1929) pp. 61-68.

[4] W. W. Tuttle and L. E. Travis, "The Relation of Precedence of Movement in Homologous Structures to Handedness." SUPPLEMENT TO THE RESEARCH QUARTERLY, (University of Iowa Studies in Physical Education) VI, (October, 1935) pp. 3-14.

[5] O. H. Vogel "The Relation of Dominance to Acts of Skill," SUPPLEMENT TO THE RESEARCH QUARTERLY, (University of Iowa Studies in Physical Education.) VI, (October, 1935) pp. 15-18.

[6] *Op. cit.*

PROCEDURE

The primary purpose of this experiment is to study the physiological dominance of the upper and lower extremities and its relation to the performance of physical education activities. The order of response when two members of the body respond by simple flexion movements to the same stimulus was obtained in six different situations. In situation one the right arm was tested against the left; in situation two, the right foot against the left; in situation three, the right arm against the right foot; in situation four, the right arm against the left foot; in situation five, the left arm against the left foot; and in situation six the left arm was tested against the right foot.

In order to have a basis for comparing the results of the order of response test with the way subjects actually perform in physical education activities, an athletic dominance index test was made which covered a wide range of activities. This test was constructed for subjects in the upper age groups.

The athletic dominance index was not practical for subjects under ten years of age as they had not performed many of the activities listed. Subjects of this age were not considered mature enough physiologically to obtain a reliable indication on some of the activities even if they had been required to perform them. In view of this fact an indication of dominance of the subjects in the lower age groups was secured by the administration of a number of simple physical performance tests.

APPARATUS AND TECHNIQUE

The apparatus used in obtaining the order of response when two members of the body responded to the same stimulus consisted of a stimulus unit, a response unit, and a recording unit. A part of the stimulus and response units was somewhat similar to those used by Tuttle and Travis[7].

The Stimulus Unit.—The stimulus unit shown in Fig. 1 consisted of a bank of four six-volt radio pilot lights, each wired separately to a spring contact key so that any desired combination or series of flashes might be obtained.

The Response Unit.—Two separate parts made up the response unit. For the arms, two spring contact keys were mounted on an elevated base and arranged in circuit as shown in Fig. 1. For the feet, two spring contact keys were mounted on a flat platform approximately two inches above the floor and large enough to support both feet. Supports extended above the surface of the platform on the front and in the middle to make sure the keys touched the subject's feet in

[7] *Op. cit.*

approximately the same place. The circuit arrangement is shown in Fig. 1. The keys for both the feet and arms were mounted from beneath the bases in such a way that when the keys were closed the base

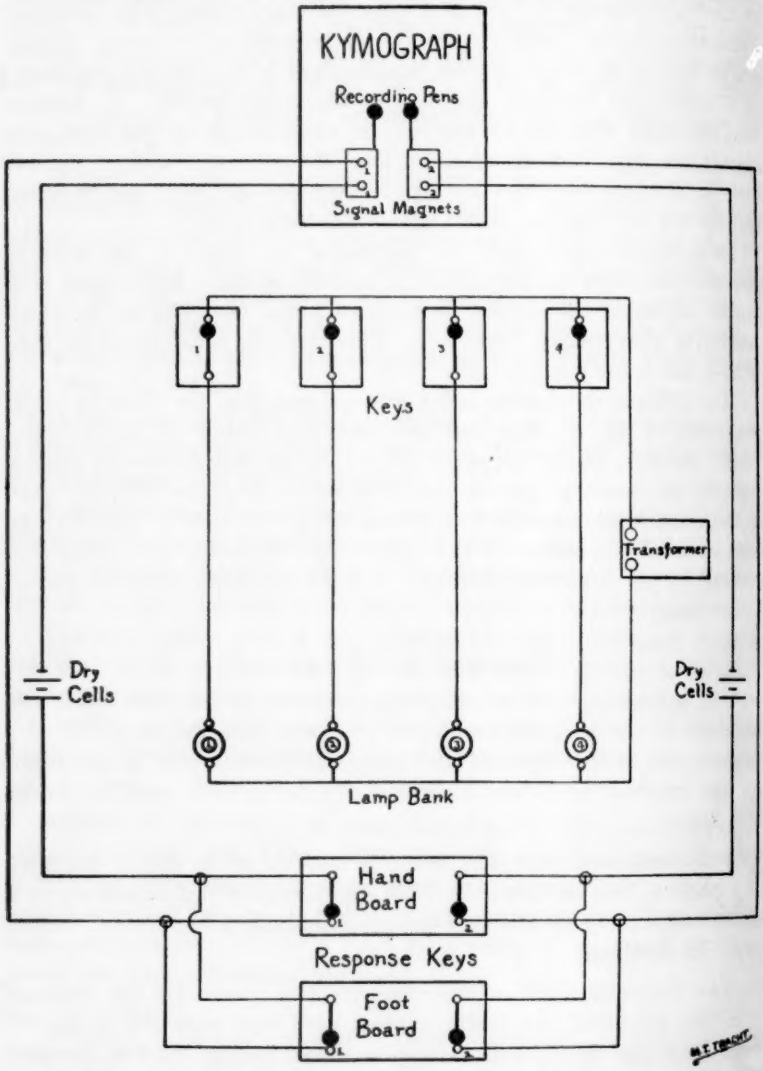

FIG. 1. Circuit arrangement for the stimulus and response units.

served as a support for the parts being tested, to permit complete relaxation. The keys for the left arm and foot were wired to the same signal magnet. The same arrangement was true for the right arm and right foot.

The Recording Unit.—The recording unit was arranged to receive the pens from the signal magnets as shown in Fig. 1. It consisted of a roll of white glazed paper, three inches in width, two rubber rollers one set above and in contact with the other and similar in appearance to a clothes wringer, two ink pens, and a synchronous motor used in turning the rubber rollers to draw the paper across a flat metal surface at the rate of 90 inches per second. The speed at which the paper moved across the metal surface was arrived at after considerable experimentation with a number of subjects. The object was to secure an optimum speed for separating the responses so that the order of response could be readily determined. The signal magnets were attached to an adjustable arm above the flat surface across which the paper moved. The ink pens were set in the signal magnets to write on the paper as it moved across the flat surface.

Obtaining a Record.—In obtaining a record the subject sat before a table on a stool adjusted to his height. The base holding the arm keys on the table was adjusted so that the subject was in a comfortable position when the backs of the forearms were placed against the keys to make the circuit. The bank of lights in the stimulus unit was placed six feet in front of the table and in line with the vision of the subject. The keys operating the lights and the recording apparatus were placed on a table behind the subject. The operator stood behind the table. The signal magnets were adjusted so that both pens touched a line, drawn by means of a straight-edge, across the paper. The pens marked an unbroken line on the glazed paper as it moved across the metal surface.

In the first situation the subject was instructed to place the backs of the forearms against the keys in the armboard and to lift the arms as quickly as possible when lamps one and two flashed simultaneously. The combination of flashes to which the subject responded was arrived at after considerable experimentation with a number of subjects. The object was to make the stimulus as difficult as possible in order to direct the attention of the subject completely to the stimulus and thereby prevent concentration on the movement of one part. The operator flashed right and wrong combinations indiscriminately so that the subject would not be forewarned of the correct combination. When the subject lifted his arms from the keys in response to the correct combination of light flashes the circuit was broken and the pens recorded a break in the line on the glazed paper as shown in Fig. 2, (L and R). Between fifteen and thirty-five records were taken of the arm responses in this situation. The number of records taken depended on the reaction of the individual. Some pupils showed signs of fatigue early due to the intense concentration required.

The foot-board containing the keys was placed under the table and adjusted to the subject in such a way that the plantar surfaces of the bare feet, just back of the metatarsal heads, would make contact with the keys to make the circuit. After a short rest the subject was

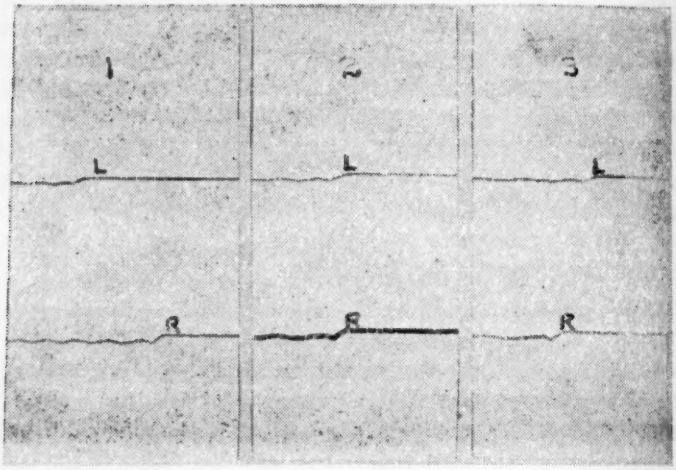

FIG. 2. Records showing (1) right lead (2) simultaneous lead (3) left lead.

instructed to place his feet on the keys in the foot-board and to raise them from the keys as quickly as possible, keeping the heels in contact with the foot-board, when lights one and two flashed together as in the first situation. Approximately the same number of records were taken in this situation as in the first.

Records in situations three, four, five, and six, as previously described, in addition to the two just mentioned were obtained in a similar manner.

Scoring the Records.—In determining the order of response from the records the paper was drawn through a box holding a straight-edge. If the breaks in the inked lines for each response occurred so close together, as shown in Fig. 2, that no difference was shown by the straight-edge, it was recorded as a simultaneous response. In case of a difference in the time of response of the two parts it was recorded in favor of the part responding first.

In scoring the records the number of responses in each situation was tabulated and totaled. The formula

$$\frac{RA+\frac{1}{2}S}{N} \times 100 \text{ *}$$

was applied to the responses in situations one, three, and four wherein

* This is a variation of the formula used in determining the laterality index.

the right arm was tested against the left arm, the right foot, and the left foot. In situation two wherein the right foot was tested against the left, the same formula was used with *RF* (right foot) being substituted for *RA*. In situations five and six wherein the left arm was tested against the left foot and the right foot, *LA* (left arm) was substituted for *RA*. In situations one, three, and four, a score between 80 and 100 inclusive indicated right arm dominance; between 0 and 20 inclusive, left arm or foot dominance; and between 21 and 79 inclusive, ambidexterity. In situation two the same divisions were used although a score between 80 and 100 inclusive indicated right foot dominance and between 0 and 20 left foot dominance. In situations five and six the same divisions were used. A score between 80 and 100 inclusive indicated left arm dominance and between 0 and 20 inclusive left or right foot dominance depending on the parts being tested.

The particular divisions for indicating dexterity were decided on after a part of the data had been collected. A preliminary study of the data showed that very few subjects responded one hundred per cent in favor of a part in any of the six situations in the order of response test. Also, the results of the simple physical tests and the athletic footedness and handedness indices showed that a large majority of individuals performed some activities with the less dominant part.

In view of these results it at once became apparent that dominance as measured by the order of response tests and the performance of physical activities must be dealt with in degrees and within certain limits. Otherwise, few of the subjects could be classed as right or left dominant although they may have responded or performed highly in favor of one part. For the purpose of this study it was thought necessary to allow for this lack of absolute dominance and set the limits so that if a large majority of the responses were in favor of one part it could be classed as dominant.

Reliability of the Order of Response Tests.—The reliability of the order of response test was determined in each of the six situations by administering the tests a second time to 76 subjects. The reliability coefficient for the right arm versus the left arm was $.95 \pm .007$; the right foot versus the left foot, $.84 \pm .02$; the right arm versus the right foot, $.88 \pm .02$; the right arm versus the left foot, $.93 \pm .01$; the left arm versus the left foot, $.90 \pm .01$; and the left arm versus the right foot, $.89 \pm .02$.

Athletic Dominance Index.—In securing an indication of athletic dominance or the way in which subjects taking the order of response test actually performed certain skills in physical education activities, a list of twenty-four questions pertaining to the hands and twenty-two questions pertaining to the feet were answered by each subject ten years of age and above. Forms 1 and 2 show these questions.

A number of different sports are represented in the questions pertaining to the use of the hands. A majority of the questions were asked on phases of a sport wherein it required a preference of one arm in performing the activity. The same procedure was followed in making the questions pertaining to the feet although foot dominance is not as readily determined as in the arm due to a lack of knowledge regarding the function of a dominant foot in performing some acts of skill. The

FORM 1

ATHLETIC HANDEDNESS INDEX

Name ..... Age..... Sex..... Date.....

Present handedness.....Give any details concerning a change in handedness .....

Put a circle around the R, L, or E found in the right-hand margin following each question to show whether you *prefer* to use your right, left, or either hand in the activity described.

1. When playing baseball, with which hand do you prefer to throw? .. R L E
2. With which hand do you prefer to throw a football? ..... R L E
3. When playing tennis, with which hand do you prefer to hold the racket? ..... R L E
4. When playing basketball, which hand do you prefer to extend above your head on a jump ball? ..... R L E
5. When playing basketball, with which hand do you prefer to shoot for basket when coming in on the right side of the backboard? ..... R L E
6. When playing basketball, with which hand do you prefer to shoot for basket when coming in on the left side of the backboard? ..... R L E
7. When playing handball, with which hand do you prefer to serve? .. R L E
8. When playing golf, with which hand do you prefer to place your ball on the tee? ..... R L E
9. When playing volleyball, if you do not hit the ball with both hands, with which hand do you prefer to hit it? ..... R L E
10. With which hand do you prefer to pitch horseshoes? ..... R L E
11. With which hand do you prefer to put a shot? ..... R L E
12. With which hand do you prefer to throw a javelin? ..... R L E
13. With which hand do you prefer to throw a discus? ..... R L E
14. When playing basketball, with which hand do you prefer to dribble the ball? ..... R L E
15. When playing badminton, with which hand do you prefer to hold the racket? ..... R L E
16. When playing volleyball, with which hand do you prefer to serve? .. R L E
17. When playing ping-pong, with which hand do you prefer to hold the paddle? ..... R L E
18. When playing softball, with which hand do you prefer to pitch? .... R L E
19. When playing softball, with which hand do you prefer to catch the ball when making a one-handed catch? ..... R L E
20. When doing the jump and reach, with which hand do you prefer to hold the chalk? ..... R L E
21. When shooting an arrow, with which hand do you prefer to draw the bow? ..... R L E

22. When shooting a gun, with which hand do you prefer to pull the trigger? ..... R L E
23. When playing baseball, how do you prefer to bat? ..... R L E
24. When playing golf, how do you prefer to drive? ..... R L E

FORM 2

Athletic Footedness Index

Name ..... Age..... Sex..... Date.....

Present footedness.....Give any details concerning a change of footedness .....

Put a circle around the R, L, or E found in the right hand margin following each question to show whether you *prefer* to use your right, left, or either foot in the activity described.

1. When playing soccer, with which foot do you prefer to make a free kick? ..... R L E
2. When playing soccer, with which foot do you prefer to dribble? ... R L E
3. With which foot do you prefer to punt a football? ..... R L E
4. In starting a sprint, which foot do you prefer back? ..... R L E
5. When hurdling, which foot crosses the hurdle last? ..... R L E
6. When doing a hopping relay, on which foot do you prefer to hop? .. R L E
7. When doing a standing hop, step, and jump, on which foot do you prefer to make the hop? ..... R L E
8. When doing the running high jump, which foot leaves the ground last? ..... R L E
9. When doing the running broad jump, which foot leaves the ground last? ..... R L E
10. When shooting free throws, which foot do you prefer back? ..... R L E
11. When doing a pivot in basketball, with which foot do you prefer to step? ..... R L E
12. When playing basketball, which foot leaves the floor last in jumping to shoot for the basket? ..... R L E
13. When swimming, with which foot do you prefer to push off from the side of the tank? ..... R L E
14. When doing a rope skip with one foot, on which foot do you prefer to skip? ..... R L E
15. In taking a football linesman's stance, which foot do you prefer back? ..... R L E
16. When climbing a ladder, with which foot do you prefer to take the first rung? ..... R L E
17. When playing soccer, with which foot do you prefer to kick a moving ball? ..... R L E
18. When doing a running hop, step, and jump, with which foot do you prefer to hop? ..... R L E
19. When ice skating, which foot do you prefer to lift from the ice in making turns? ..... R L E
20. When roller skating, which foot do you prefer to lift from the floor in making turns? ..... R L E
21. With which foot do you prefer to drop kick a football? ..... R L E
22. When mounting a bicycle, which foot do you prefer to swing over? R L E

entire list of questions for both the feet and hands was selected after considerable experimentation in administering questions and having pupils perform the activity asked in the questions to a number of subjects at various age levels.

In administering the test, if a subject was doubtful about which hand or foot he used in performing the activity asked in any question, he was instructed to try the activity before giving the answer in order to be sure the answers were reliable. Each question was answered as to whether the subject used his right or left arm or right or left foot in performing the activity. If there was no preference it was so indicated.

Scoring the Athletic Dominance Index.—In scoring both the handedness and footedness questions, the number of right, left, and simultaneous responses was determined and the formula

$$\frac{R+\frac{1}{2}E}{N} \times 100$$

was used. The same divisions to indicate dominance as in the order of response test were used in this test. That is, a score between 80 and 100 inclusive indicated right dominance; between 21 and 79 inclusive ambidexterity; and between 0 and 20 inclusive left dominance.

Reliability of the Athletic Dominance Index.—The athletic dominance index tests for both handedness and footedness were given a second time to find whether the results would be consistent. Sixty-nine cases were included for handedness and seventy cases for footedness.

The reliability coefficient for the handedness index was .99±.001. However the unequal distribution of cases cast some doubt on the results of the correlation. For that reason the scores for the fifty right-handed subjects, after excluding the scores for the left-handers and ambidexters, were correlated. The reliability coefficient was .64±.06. This coefficient was unusually low in comparison due to the fact that the scores for right-handed subjects, according to the divisions set for handedness, ranged between 80 and 100 inclusive, which meant that step-intervals were small and a slight change unduly affected the reliability coefficient as such close discrimination is unnecessary in measuring dominance.

The reliability coefficient for footedness as measured by the athletic dominance index was .97±.006.

Simple Physical Tests for Boys under Ten Years of Age.—For boys under ten years of age, the following simple physical performance tests were given to secure an indication of arm and foot dominance:

1. The soccer free kick.
2. The soccer dribble.
3. Hopping on one foot.
4. Jumping a gap between mats.
5. Standing start from behind a line.
6. Arm and shoulder girdle strength as measured by an inverted back and leg dynamometer.
7. Baseball batting.
8. Baseball throwing.
9. Dribbling a 14-inch softball with a hockey stick.

These tests are described in detail in Form 3.

FORM 3

Description of Simple Physical Tests for Boys Under Ten Years of Age

Soccer Free Kick.—A regulation soccer ball was placed on the ground and the subject was asked to take a short run and kick it. The foot used in kicking the ball on each trial was recorded as the dominant foot.

Soccer Dribble.—A regulation soccer ball was placed on the ground and the subject was asked to dribble the ball a distance of thirty yards. The foot used in dribbling in each trial was recorded as the dominant foot.

Hopping on One Foot.—The subject was asked to hop a distance of thirty feet on one foot. The foot used in hopping was recorded in each trial.

Standing Start from Behind a Mark.—A line two feet in length was drawn with chalk on the gymnasium floor to serve as a starting line. The subject was asked to assume a standing start position behind the starting line. At a signal from the starter the subject ran ten yards. The back foot in the starting position was recorded in each trial as the dominant foot.

Jumping a Five-Foot Gap Between Gymnasium Mats.—Two gymnasium mats were arranged to provide a five-foot gap between them. The subject was asked to take a short run and jump the gap. The foot leaving the mat last was recorded in each trial as the dominant foot.

Arm and Shoulder Girdle Strength.—A back and leg dynamometer was inverted and attached to an over-head frame so that the height could be adjusted to the subject. The handle ordinarily attached to the chain of the dynamometer was removed and a flying ring was attached in its place in order to provide a secure grip for the hand.

In giving the test the dynamometer was adjusted to the height of the subject so that the plantar surfaces of the feet touched the floor with the arm gripping the ring fully extended above the head. Each subject was permitted one practice pull with each arm. Then he was given two pulls with each arm and the best score in pounds recorded as dominant. The subject was asked to alternate the order of the arms in securing the final score.

Hockey Dribble.—A 14-inch softball and a hockey stick were given to the subject. He was asked to dribble the ball a distance of thirty yards. The score was recorded as to whether he dribbled the ball right-handed or left-handed.

Baseball Batting.—The subject was asked to select a bat from several lying on the ground and take his batting position beside home plate. He was permitted to swing at three pitches. A 12-inch softball was used. The score was recorded as to whether he batted right-handed or left-handed.

Baseball Throw.—The subject was asked to throw a 12-inch softball at a canvas target. The arm used in throwing was recorded.

Scoring the Simple Physical Tests.—In scoring the records of the five tests pertaining to the feet, an attempt was made to secure a dominance index comparable to the order of response scores and the athletic dominance index administered to the upper age groups. To obtain this index for each subject the number of right foot and left foot performances in the ten trials of each test was totalled and the formula

$$\frac{R}{N} \times 100$$

was applied. In this formula R equals the number of right foot performances and N equals the total number of performances. Although the index secured is similar to the scores on the order of response tests and the athletic index they must be compared with reservations for in administering the simple physical tests no provisions were made for preferences as in the athletic index tests.

The simple physical tests obtained to indicate arm dominance were not considered reliable enough measures of pure arm dominance to warrant their being combined for an index. The results of these tests will be discussed and treated separately, largely for the purpose of showing the influence of certain factors in dealing with arm dominance, rather than as an indication of dominance free from bilateral influences and early conditioning.

In the arm and shoulder girdle strength test the arm having greater strength was considered as the dominant arm for the purpose of this study. In case the strength of the two arms was equal they were considered ambidextrous.

In the baseball throwing, baseball batting, and the hockey dribble tests the score for each subject was recorded either right or left corresponding to actual performance.

DATA AND DISCUSSION

The subjects for this experiment consisted of 239 elementary and high-school boys ranging in ages from six to eighteen years. The entire group was tested in situations one and two of the order of response tests, wherein the right arm was tested against the left arm and the right foot against the left foot. One hundred twenty-four of the subjects ten years of age and above were tested in situations three, four, five, and six wherein the right arm was tested against the right foot,

the right arm against the left foot, the left arm against the left foot, and the left arm against the right foot.

The athletic index for both the arms and feet was secured on the 154 subjects ten years of age and above. For boys under ten years of age, simple physical tests were given to secure an indication of dominance.

For purposes of comparison four age groups were used. Group one consisted of pupils six to nine years inclusive; group two, subjects ten to twelve years inclusive; group three, subjects thirteen to fifteen years inclusive; and group four, subjects sixteen to eighteen years inclusive.

Tables I, II, and III show the results of the subjects' statements of handedness and footedness, the order of response test, and the physical tests to determine footedness in group one. According to Table I, 80 per cent stated that they were right-handed, 20 per cent left-handed, and none ambidextrous; 80 per cent were right-footed, 18 per cent left-footed, and 2 per cent ambidextrous with respect to the feet. By the order of response test 47 per cent of the 85 subjects were right-handed, 18 per cent left-handed, and 35 per cent ambidextrous. Seven per cent were right-footed, 21 per cent left-footed, and 72 per cent ambidextrous. Twenty-six per cent of the 85 subjects according to the physical tests for footedness were right-footed, 9 per cent left-footed, and 65 per cent ambidextrous.

Assuming that the stronger arm is the dominant arm 38 per cent of the 85 subjects in group one were right-arm dominant, 32 per cent left-arm dominant, and 31 per cent may be considered ambidextrous since they registered the same score with both arms.

Eighty per cent of the subjects in group one both batted and threw right-handed and 17 per cent performed these acts with the left hand. Eight-two per cent dribbled the softball with a hockey stick right-handed and 18 per cent left-handed. It should be noted that no provisions were made for ambidexterity in baseball throwing, batting, and the hockey dribble test, for actual performance in these activities seemed to have been established at an early age. Any number of trials given in administering the tests brought the same results with each individual.

TABLE I

SUMMARY OF THE RESULTS OF THE SUBJECTS' STATEMENTS OF HANDEDNESS AND FOOTEDNESS IN GROUP ONE

Age	No. of Cases	Handedness			Footedness		
		RA	LA	A	RF	LF	A
6	3	3	0	0	3	0	0
7	32	27	5	0	26	6	0
8	21	19	2	0	19	2	0
9	29	19	10	0	20	7	2
Total	85	68	17	0	68	15	2
Per cent		80	20	0	80	18	2

TABLE II

SUMMARY OF THE RESULTS OF THE ORDER OF RESPONSE TEST IN SITUATIONS ONE AND TWO SHOWING THE DOMINANCE IN GROUP ONE

Age	No. of Cases	First Situation			Second Situation		
		RA	LA	A	RF	LF	A
6	3	3	0	0	0	0	3
7	32	17	5	10	2	7	23
8	21	10	3	8	1	4	16
9	29	10	7	12	3	7	19
Total	85	40	15	30	6	18	61
Per cent		47	18	35	7	21	72

TABLE III

SUMMARY OF THE RESULTS OF THE PHYSICAL TESTS GIVEN TO SUBJECTS UNDER TEN YEARS OF AGE TO DETERMINE FOOTEDNESS (GROUP ONE)

Age	No. of Cases	Dominance		
		RF	LF	A
6	3	0	0	3
7	32	11	3	18
8	21	6	1	14
9	29	5	4	20
Total	85	22	8	55
Per cent		26	9	65

A comparison of subjects' statements of handedness and the results of the order of response tests in group one showed that there is but little agreement between them. This might be expected as young children are likely to determine their handedness by the performance of a few activities such as writing or throwing a baseball. The baseball batting, baseball throwing, and the hockey dribble supported the subjects' statements. However, these activities are likely to be conditioned at an early age in the subjects and the results were as expected. The results of dominance as measured by the arm and shoulder girdle strength were in harmony with the order of response test.

There was a wide difference between subjects' statements of footedness and the results as shown by the order of response test. Apparently the subjects tended to think that the same foot and arm are dominant. This is logical in that foot dominance is not as readily determined as arm dominance and there are not so many situations wherein foot preference is involved. The results of footedness as determined by actual performance in the five simple physical tests are in harmony with the results of the order of response test and in disagreement with the subjects' statements of footedness.

Tables IV, V, and VI show a summary of the results of subjects' statements of handedness and footedness, the order of response test, and the athletic dominance index in groups, two, three, and four.

TABLE IV

SUMMARY OF THE RESULTS OF THE SUBJECTS' STATEMENTS OF HANDEDNESS AND FOOTEDNESS IN AGE GROUPS TWO, THREE, AND FOUR

Age	No. of Cases	Handedness			Footedness		
		RA	LA	A	RF	LF	A
		Group Two					
10	23	17	6	0	17	6	0
11	9	4	5	0	4	5	0
12	14	10	4	0	9	4	1
Total	46	31	15	0	30	15	1
Per cent		67	33	0	65	33	2
		Group Three					
13	13	12	1	0	12	1	0
14	29	26	3	0	26	3	0
15	20	18	2	0	17	1	2
Total	62	56	6	0	55	5	2
Per cent		90	10	0	89	8	3
		Group Four					
16	20	18	2	0	19	1	0
17	19	17	2	0	16	2	1
18	7	7	0	0	7	0	0
Total	46	42	4	0	42	3	1
Per cent		91	9	0	91	7	2
Total							
All Cases	154	129	25	0	127	23	4
Per cent							
All Cases		84	16	0	82	15	3

TABLE V

SUMMARY OF THE RESULTS OF THE RIGHT ARM AGAINST THE LEFT ARM AND THE RIGHT FOOT AGAINST THE LEFT FOOT OF THE ORDER OF RESPONSE TEST IN AGE GROUPS TWO, THREE, AND FOUR

Age	No. of Cases	First Situation			Second Situation		
		RA	LA	A	RF	LF	A
		Group Two					
10	23	11	5	7	5	1	17
11	9	2	5	2	2	2	5
12	14	5	5	4	8	2	4
Total	46	18	15	13	15	5	26
Per cent		39	33	28	33	11	57
		Group Three					
13	13	7	1	5	2	0	11
14	29	18	4	7	3	4	22
15	20	14	2	4	4	4	12
Total	62	39	7	16	9	8	45
Per cent		63	11	26	15	13	73
		Group Four					
16	20	14	3	3	7	4	9
17	19	11	1	7	7	2	10
18	7	4	0	3	1	3	3
Total	46	29	4	13	15	9	22
Per cent		63	9	28	33	20	48
Total							
All Cases	154	86	26	42	39	22	93
Per cent							
All Cases		56	17	27	25	14	60

TABLE VI

SUMMARY OF THE RESULTS OF THE ATHLETIC INDEX SHOWING DOMINANCE IN AGE GROUPS TWO, THREE, AND FOUR

Age	No. of Cases	Handedness			Footedness		
		RA	LA	A	RF	LF	A
		Group Two					
10	23	17	6	0	3	2	18
11	9	4	4	1	0	1	8
12	14	10	3	1	5	4	5
Total	46	31	13	2	8	7	31
Per cent		67	28	4	17	15	67
		Group Three					
13	13	11	1	1	2	0	11
14	29	26	1	2	10	0	19
15	20	18	2	0	6	0	14
Total	62	55	4	3	18	0	44
Per cent		89	6	5	29	0	71
		Group Four					
16	20	17	2	1	3	0	17
17	19	17	1	1	6	1	12
18	7	7	0	0	4	0	3
Total	46	41	3	2	13	1	32
Per cent		89	7	4	28	2	70
Total							
All Cases	154	127	20	7	39	8	107
Per cent							
All Cases		82	13	5	25	5	69

In group two, 67 per cent of the 46 cases said that they were right-handed, 33 per cent left-handed, and none ambidextrous; 65 per cent were right-footed, 33 per cent left-footed; and 2 per cent ambidextrous. According to the order of response test 39 per cent of the 46 cases were right-handed, 33 per cent left handed, and 28 per cent ambidextrous; 33 per cent were right-footed, 11 per cent left-footed, and 57 per cent ambidextrous. By the athletic dominance index, 67 per cent were right-handed, 28 per cent left-handed, and 4 per cent ambidextrous; 17 per cent were right-footed, 15 per cent left-footed, and 67 per cent ambidextrous.

Ninety per cent of the 62 cases in group three stated that they were right-handed, 10 per cent left-handed, and none ambidextrous; 89 per cent were right-footed, 8 per cent left-footed, and 3 per cent ambidextrous. Sixty-three per cent of the 62 cases in group three were right-handed according to the order of response test, 11 per cent left-handed, and 26 per cent ambidextrous; 15 per cent were right-footed, 13 per cent left-footed, and 73 per cent ambidextrous. By the athletic index 89 per cent were right-handed, 6 per cent left-handed, and 5 per cent ambidextrous; 29 per cent were right-footed, none left-footed, and 71 per cent ambidextrous.

The results of the subjects' statements in group four showed 91 per cent of the 46 subjects right-handed, 9 per cent left-handed, and none ambidextrous; 91 per cent were right-footed, 7 per cent left-

footed, and 2 per cent ambidextrous. By the order of response test 63 per cent of the 46 cases were right-handed, 9 per cent left-handed, and 28 per cent ambidextrous; 33 per cent were right-footed, 20 per cent left-footed, and 48 per cent ambidextrous. The athletic index showed 89 per cent right-handed, 7 per cent left-handed, and 4 per cent ambidextrous; 28 per cent were right-footed, 2 per cent left-footed, and 70 per cent ambidextrous.

The total results for the 154 cases in groups two, three, and four showed that according to their statements of handedness and footedness 84 per cent were right-handed, 16 per cent left-handed, and none ambidextrous; 82 per cent were right-footed, 15 per cent left-footed, and 3 per cent ambidextrous. By the order of response test 56 per cent were right-handed, 17 per cent left-handed, and 27 per cent ambidextrous; 25 per cent were right-footed, 14 per cent left-footed, and 60 per cent ambidextrous. The total results of the athletic index secured on 154 subjects ten years of age and above showed 82 per cent were right-handed, 13 per cent left-handed, and 5 per cent ambidextrous; 25 per cent were right-footed, 5 per cent left-footed, and 69 per cent ambidextrous.

A comparison of the results of the athletic index test, the order of response test, and the subjects' statement of dominance shows:

1. There is close agreement between subjects' statements of handedness and the way they actually perform as shown by the athletic index. However, there is but little agreement between statements and performances with regard to footedness since 82 per cent of the 154 subjects on which the athletic index was obtained stated that they were right-footed and 2 per cent ambidextrous. Actually, 25 per cent were right-footed and 69 per cent ambidextrous.

The discrepancy between the subjects' statements of footedness and the way they actually perform as shown by the athletic index was in agreement with the results shown in group one and may be attributed to the same reasons as those stated for group one. That is, there is less conscious use of the feet with respect to dominance combined with the fact that in the performance of many activities the dominant foot is not always easily determined.

2. There is a lower percentage of right-handed subjects in each age group according to the order of response test than by the athletic index test. The reverse is true of ambidexterity. This indicates that many of the subjects actually performing activities right-handed are inherently ambidextrous as the number of left-handed subjects seems to remain fairly constant in all age groups. The fact that many changes occur from right-handedness to ambidexterity while the left-handed

group remains fairly constant indicates the operation of social pressure to right-handedness.

3. The order of response test, the athletic index, and the simple physical tests are in agreement in showing a lack of foot dominance comparable to the arms. According to the results of the tests a majority of subjects are classed as ambidextrous with respect to the feet and apparently have not established foot dominance. This might be expected due to the fact that there is less pressure to footedness than to handedness. Both the athletic index and the order of response test show a higher percentage of ambidexterity of the feet than hands in all age groups.

A comparison of the handedness and footedness of the 154 subjects in groups two, three, and four by the order of response test and the athletic dominance index test shows that 65 per cent of the 127 right-handed subjects by the athletic dominance index test were right-handed by the order of response test, 3 per cent left-handed, and 32 per cent ambidextrous; of the 20 left-handed subjects by the athletic index test, 5 per cent were right-handed, 90 per cent left-handed, and 5 per cent ambidextrous by the order of response test. In the athletic index ambidextrous group, 29 per cent were right-handed, 57 per cent left-handed, and 14 per cent ambidextrous; of the 39 subjects in the right-footed group by the athletic index, 33 per cent were right-footed, 13 per cent left-footed, and 54 per cent ambidextrous. In the left-footed group according to the athletic index, 13 per cent were right-footed, 50 per cent left-footed, and 38 per cent ambidextrous by the order of response test. In the athletic index ambidextrous group, 23 per cent were right-footed, 12 per cent left-footed, and 64 per cent ambidextrous. The results of this comparison show that 44 of the 127 subjects in the athletic index right-handed group were not right-handed by the order of response test. However, 40 of the subjects were lost to the ambidextrous group against 4 to the left-handed group. The left-handed group seemed to remain constant as 18 of the 20 subjects were left-handed by both tests. This seems to indicate that if the inherent left-handed tendency in a subject is such that he remains left-handed in performing activities regardless of outside pressure, there is likely to be less question about his handedness.

The comparison of footedness shows that 26 of the 39 right-footed subjects by the athletic index are not right-footed by the order of response test. Twenty-one of the 26 were lost to the ambidextrous group. In the athletic index ambidextrous group, 38 of the 107 subjects were not ambidextrous with respect to the feet by the order of response test. This lack of agreement between the footedness as measured by the order of response test and the athletic index might be

expected in view of the fact that all tests showed the majority of subjects ambidextrous.

Table VII shows the results of the order of response test for 124 subjects in situations three, four, five, and six. In situation three wherein the right arm was tested against the right foot, 59 per cent were arm dominant, 2 per cent foot dominant, and 39 per cent exhibited no dominance; the right arm against the left foot showed 40 per cent arm dominant, 6 per cent foot dominant, and 55 per cent showed no dominance; the left arm against the left foot showed 58 per cent arm dominant, 3 per cent foot dominant, and 39 per cent showed no dominance; the left arm against the right foot revealed 58 per cent arm dominant, 7 per cent foot dominant, and 35 per cent showed no dominance.

The results of the order of response tests in situations three, four, five, and six indicate:

1. When dominance between the arms and feet exist, it is in favor of the arms, although there are a large number of cases in which no dominance is exhibited.

2. There seemed to be a tendency for the right arm to be dominant over the right foot more often than over the left foot.

3. Right arm dominance in situations three and four became more pronounced in the upper age groups.

TABLE VII

SUMMARY OF THE RESULTS OF THE ORDER OF RESPONSE TEST IN SITUATIONS THREE, FOUR, FIVE, AND SIX SHOWING DOMINANCE IN EACH OF THE FOUR AGE GROUPS*

Group	No. of Cases	Third Situation			Fourth Situation			Fifth Situation			Sixth Situation		
		RA	RF	A	RA	LF	A	LA	LF	A	LA	RF	A
One	18	6	2	10	4	2	12	9	1	8	14	1	3
Per cent		33	11	56	22	11	67	50	6	44	78	6	17
Two	22	10	0	12	5	2	15	14	0	8	18	1	3
Per cent		45	0	55	23	9	68	64	0	36	82	5	14
Three	43	31	1	11	26	0	17	24	2	17	22	2	19
Per cent		72	2	26	60	0	40	56	5	40	51	5	44
Four	41	26	0	15	14	3	24	25	1	15	18	5	18
Per cent		63	0	37	34	7	59	61	2	37	44	12	44
Total	124	73	3	48	49	7	68	72	4	48	72	9	43
Per cent		59	2	39	40	6	55	58	3	39	58	7	35

* Situation three, right arm against the right foot; situation four, right arm against the left foot; situation five, left arm against the left foot; situation six, left arm against the right foot.

4. Left arm dominance in situation five remained fairly constant in all age groups.

5. Left arm dominance in situation six was more distinct in the lower age groups.

SUMMARY AND CONCLUSIONS

The purpose of this investigation is to study the relationship of the order of response when two members of the body respond to the same stimulus to the performance of physical education activities. In the upper age groups an athletic performance test covering a wide range of physical education activities was used as a basis for comparison. In the lower age groups an indication of dominance was secured through the administration of simple physical tests.

From the results of the data secured from 239 elementary and high schools boys the following conclusions were drawn:

1. The results of both the athletic dominance index and the order of response test on 239 subjects show that handedness does not approximate a normal distribution. The scores for footedness were more evenly distributed due to the fact that a much higher percentage of subjects were ambidextrous with respect to the feet.

2. There is close agreement between subjects' statements of handedness and actual performance. The reverse is true for footedness. Apparently the subjects tended to think that the same foot and arm are dominant. This is likely due to the less conscious use of the feet with respect to dominance combined with the fact that in the performance of many activities the dominant foot is not always easily determined.

3. The results of the order of response test, the athletic index, and the simple physical tests indicate that a majority of the subjects are ambidextrous with respect to the feet and even in the upper age groups foot dominance had not been thoroughly established as shown by actual performance. The lack of foot dominance throughout all age groups tested may be due partly to a lack of social pressure in footedness. In handedness social pressure may have been a strong influence in the earlier years.

4. When the arms and feet are tested against each other the indications are that dominance is in favor of the arms. There were few cases where a foot was dominant when tested against an arm. However, there were a number of cases wherein no dominance was exhibited.

5. There is a lower percentage of right-handed subjects in each age group according to the order of response test than by the athletic dominance index. The total results in age groups, two, three, and four in which both measures were secured showed that by the athletic dominance index 82 per cent of the 154 subjects were right-handed. By the order of response test 56 per cent were right-handed. This indicates that many of the subjects actually performing physical education activities right-handed are inherently ambidextrous as measured

by the order of response test. This indication gains added support by the fact that in the order of response test 27 per cent of the 154 subjects were ambidextrous and by the athletic dominance index 5 per cent were ambidextrous. In other words the left-handed subjects remained fairly constant by both tests and the ambidextrous group by the order of response test increased through a change from the right-handed group by the athletic index. This change from right-handedness to ambidexterity strongly indicates that social pressure to handedness is in operation. This should not be interpreted to mean that those subjects right-handed by the athletic index yet ambidextrous by the order of response test should necessarily discontinue right-arm usage for undoubtedly many and perhaps all of them may have used the right arm dominantly if there had been no pressure to right-handedness in the beginning as the fact that they were ambidextrous gave them the same chance of performing right-handed as left-handed. However, more attention to the subjects in this group particularly during their early years may serve to eliminate some of the difficulties often arising from hand-dominance and eventually improve methods of teaching beginners.

This experiment was carried out under the direction of Dr. W W. Tuttle, Department of Physiology, University of Iowa.

Strength, Power, and "Femininity" as Factors Influencing the Athletic Performance of College Women

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FROM Eve down, or up, women have been generally considered to be the weaker sex, unable to equal, much less to excel, men in athletic performance. Miss Agnes Wayman sums up these opinions when she says, "It is commonly agreed by the medical profession and among physical educators that girls and women present certain physiological, anatomical, and emotional differences which should limit to a certain extent their participation in physical activities."[41]*

From the physiological point of view, it seems to be agreed that men are stronger than women. Rogers states that "In New York an investigation of the strength of munition workers revealed that the average industrial woman had less than half the strength of the average industrial man." He continues, "Man is about 43 per cent muscle and woman about 36 per cent muscle." Williams, Dambach, and Schwendener contribute, "In proportion to weight and size the arm and shoulder muscles of the male are stronger than those of the female."[10] Still in a physiological vein, Wood and Brownell state, "Metabolism is less rapid in women than men, the ratio being 100 to 141. Women, biologically, are in general anabolic in type, while men are catabolic."[16] Scales for determining the Physical Fitness Index for men and women are different. The men are consistently expected to have greater strength for their height and weight.

On the anatomical side women are again at a disadvantage. As Williams says, "The pelvis of the female is much broader after adolescence, which gives to the femur a marked obliquity. This mechanical disadvantage interferes with the running ability of the girl. In all movements of the lower extremities there is likely to be a marked lateral sway of the pelvis."[9] Other authorities agree with general statements similar to Sharman's, "Women and girls are not so well suited mechanically as are men and boys to participate in events requiring speed in running or unusual muscular strength."[13]

*Indices refer to Bibliography at end of article.

McCurdy sums up the situation when he states, "Differences in the type of exercise depend chiefly upon the differences in the physical structure of man and woman. Women are smaller than men and they are built in different proportions. The arms and legs are proportionally shorter, the trunk longer, the pelvis much broader. The oblique angle at which the thigh bone is attached to the pelvis interferes with the ability of women in running. Red corpuscles are less numerous in women than in men. Limited physical strength in women may be partially due to lack of use, but physiologic differences are also operative."[15]

With these opinions in mind, this study was undertaken in order to determine to what extent the frequently mentioned strength, power, and "femininity" influence athletic performance.

The strength factor in this study is considered in two ways. The Total Strength is the result of adding the scores for back and leg lift, chin, dip, right and left grip, push, pull, and twenty tests using the Martin technique.[5] The Physical Fitness Index is computed from the scores of each individual in the tests included in the Rogers battery omitting lung capacity.[3] Total Strength gives the individual's attained score; P. F. I. gives the strength in relation to what it should be for her age and weight.

The Sargent Jump is considered to be an excellent indication of an individual's power. The score for the Sargent Jump is used in this study to represent the power factor.

The track and field events included a sixty-yard dash, six-pound shot-put, and standing broad jump. These were scored according to tables based on data from a large group. Because achievements in track and field have been shown to be most typical of an individual's athletic ability, the scores of these three events combined are used in this study as an indication of the individual's athletic performance.

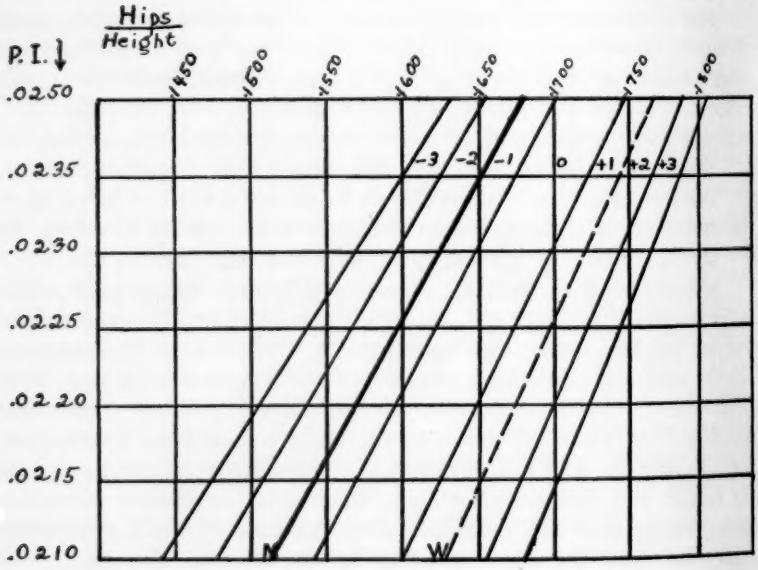
The femininity was more difficult to score because no plan for its determination is to be found in the literature. Therefore, a scale for scoring masculinity or femininity of build had to be worked out.

Measurements of shoulder breadth, thigh girth, elbow width, chest girth corrected for fat, and hip width corrected for fat were secured for one hundred college men and as many college women. The material for the men was taken from the data of Dr. Everett Marshall and Mr. Earl Greene. The measurements were all taken according to directions published by McCloy.[1] Each measurement was divided by the individual's height. The Ponderal Index, the cube root of weight divided by height, was computed for each individual. Correlations were then computed between the ponderal index and each of the five measurements for men; the same was done for the women. Regression lines

were computed and drawn on each scatter diagram. These were then paired off, shoulders of men and women, hips, chests, elbows, and thighs. A large chart was drawn for each pair of regression lines allowing for the lowest and highest scores for both. The regression lines were then transferred to the charts, thus showing graphically the difference between the men's and women's averages for each measurement.

In order to score how far an individual deviated from the women's average toward the men's side, masculinity or in the opposite direction, femininity, lines were fitted by mathematical formulae to divide into four equal parts the space between the men's regression line and the women's regression line. Each of these four divisions was considered a zone. In order to measure further deviation either way several more zones of equal space were fitted to the far sides of the regression lines. The charts were then ready for use in scoring individuals. The two center zones between the masculine and the feminine averages were considered zero. The zone from zero toward the masculine average was considered —1, or one toward masculinity, the next zone —2, and so on. The zone between zero and the feminine average was 1, next 2, and so on. Consequently, if a score read —7 the individual would be judged to be quite masculine in that trait while if the score were 7 she would be judged to be quite feminine in the measurements being scored.

Example of chart:



An individual having a ponderal index of .0225 and a hip index of .1580 would have a femininity rating of —2 for that measurement. Another having a ponderal index of .0225 and a hip index of .1730 would have a femininity rating of 3 for that measurement.

When these charts were completed, every girl was scored for each of her measurements and the five scores were added to give her a femininity rating. In many cases the scores were consistently masculine or feminine. In many others, however, there were sharp differences between measurements, or one score would be so greatly different that the total would be thrown in its direction. This was often due to shoulders. When each of the scores was correlated with the total, shoulders showed an r of .7419 with the total. The next highest correlation with the total was thigh girth with an r of .3923. Shoulders showed a higher correlation by almost .5 (.4496). This looked suspicious. It was then decided to determine the standard error of the difference. This was divided into the difference itself. For the shoulder index, this was only .192, which showed that although shoulders vary considerably, they vary as considerably in both sexes so that they are not a true differentiator between the sexes. The four other indices gave ratios that ranged between 8.04 and 12.2, demonstrating that they are of much greater value. It was decided to multiply each of the four scores by 10, leave shoulders out, and thus by adding the four get a true femininity rating. Now, with the four measures of body build and the Ponderal Index, an individual's type of build from the standpoint of femininity could be quickly judged through the use of these charts.

With the scales determined and the femininity scores for each of the one hundred college women tabulated, the problems in the study of the influence of strength, power, and femininity upon athletic performance could be attacked.

In all of the correlations given below, the following notation will be used:

0 = Track and Field score
1 = Femininity score
2 = Sargent Jump
3 = P.F.I.
4 = Iowa Brace test
5 = Burpee test
6 = Percentage over or underweight for build.

It was thought that over and underweight might have some influence on the various scores. The percentage of over or underweight was computed and correlated with the various items used in the study

(See Table II). This showed a slightly negative correlation with track and field, Sargent Jump, the Iowa Brace test, and the Burpee test, a slightly positive correlation with P.F.I. and with femininity. Over and underweight seemed, also, to have a negligible effect on correlations when it was partialed out, or held constant (see Table III).

To what extent does the strength of an individual affect her athletic performance? In order to answer this question the track and field scores combined were correlated with the total strength score giving an r of .3959. The P.F.I. score was then correlated with track and field resulting in an r of .3347. Although these correlations are somewhat low, they show a definitely positive relationship between strength and athletic performance. It may, then, be assumed that the stronger individuals are superior to the weaker in athletic performance as judged by their track and field records. It will be found, however, upon reference to Table III that partialling out the P.F.I. results in a surprisingly slight lowering of the zero order correlations.

Are the individuals possessed of more power superior in athletic performance? For the answer to this question, Sargent Jump records were correlated with those for track and field. The resulting r of .5267 demonstrated that there is a positive relation between power and athletic performance as judged by track and field scores. Wherever Sargent Jump is partialed out, or held constant, the r is lowered, made a smaller positive or a larger negative correlation (see Table III). This would seem to indicate further that power is an important component of an individual's several abilities.

When both the Sargent Jump and the P.F.I. are combined to predict track and field, a much better result is obtained, $R\ 0.23 = .5748$. When these are added to the femininity score, a multiple correlation of .6058 is obtained.

The third question would then be: Are the individuals who are more feminine of build superior in athletic performance to those of more masculine build? The femininity rating was correlated with the track and field scores. In this case $r = -.1892 \pm .0650$ a small negative relation showing that the masculine build is so very slightly more favorable to athletic performance as to be a rather negligible factor—much less important than the factors of strength and spring. Hips alone correlated with dash alone gave an r of $-.0514$, an even smaller correlation than that of the totals, $-.1892$. When some combinations of Sargent Jump, P.F.I., and over and underweight are held constant, however, the femininity index shows a higher correlation with athletic ability (see Table III). It goes only as high as $-.2960$, not a very significant correlation. It is always negative, thus indicating that the masculine type of build is always a slight advantage athletically.

The next question is that of the effects of differences in motor educability and skill. The Iowa revision of the Brace test and the Burpee test[6] were used to measure this as well as possible. The story is told by the zero order and multiple correlations obtained.

$$r\ 04 = .4947$$
$$r\ 05 = .3499$$
$$R\ 0.45 = .5009$$
$$R\ 0.456 = .5213$$
$$R\ 0.24 = .6099$$
$$R\ 0.245 = .6179$$
$$R\ 0.1245 = .6570$$
$$R\ 0.12345 = .6740$$
$$R\ 0.123456 = .6741$$

It will seem that the Brace correlates very well with athletic ability, and that the addition of the Burpee test (R 0.45) does not raise this correlation appreciably. Over and underweight aid a little, but the addition of the Sargent Jump brings it up sharply. When these three are in the picture, the femininity index raises the correlation very markedly indeed. The addition to these of the P.F.I., and the over and underweight do not add much to the values of the multiple correlations. The partial correlation is $r\ 01.245 = -.2821$.

CONCLUSION

From the results of this study it would seem, first, that power, or the ability to contract the muscles under load at maximum speed, and muscular strength are the two most important factors we have measured, so far as their influence on athletic performance is concerned. Of these the power factor is by far the more important. Secondly, a masculine type of build is of relatively lesser influence upon athletic performance, though with this sampling what influence it does have was favorable to athletic ability. The factor of motor educability was found to have a large influence upon athletic ability, when combined with the Sargent Jump to give a relatively high predictive correlation, the best obtained for any two test variables.

It would seem then that programs of physical education for girls may safely disregard the matter of build, and, if they desire to promote athletic ability, may safely concentrate upon developing the requisite strength, speed, and skill related to the performance of the athletic events.

TABLE I

INTERCORRELATIONS OF FEMININITY TOTAL AND ITS COMPONENTS

	Thigh	Hips	Elbow	Chest	Femininity
Thigh	....				
Hips	—.1141	....			
Elbow	.0623	.1150	....		
Chest	—.1290	.2505	.0383	....	
Femininity	.6225	.5311	.3632	.1662	....

TABLE II

INTERCORRELATIONS

	0	1	2	3	4	5	6
0. Track and Field	....						
1. Femininity	—.1892	....					
2. Sargent Jump	.5267	.0574	....				
3. P.F.I.	.3347	—.1141	.2086	....			
4. Iowa Brace	.4947	—.0182	.4062	.1724	....		
5. Burpee	.3499	.1366	.3169	.2715	.4063	....	
6. Over and Underweight	—.0767	.1669	—.1652	.2722	—.1095	—.0440	....

TABLE III

PARTIAL AND MULTIPLE CORRELATIONS

(Zero order r given in parentheses)

$r_{01} = -.1892$
$r_{01.2} = -.2593$ (−.1892)
$r_{01.3} = -.1613$ (−.1892)
$r_{01.23} = -.2350$ (−.1892)
$r_{01.6} = -.2055$ (−.1892)
$r_{01.26} = -.2960$ (−.1892)
$r_{01.36} = -.1564$ (−.1892)
$r_{01.236} = -.2551$ (−.1892)
$r_{01.245} = -.2821$

$r_{02} = .5267$
$r_{02.1} = .5484$ (.5267)
$r_{02.3} = .4934$ (.5267)
$r_{02.13} = .5178$ (.5267)
$r_{02.6} = .5227$ (.5267)

$r_{03} = .3347$
$r_{03.1} = .3210$ (.3347)
$r_{03.2} = .2707$ (.3347)
$r_{03.12} = .2474$ (.3347)
$r_{03.26} = .2811$ (.3347)
$r_{03.6} = .3706$ (.3347)

$r_{12} = .0574$
$r_{12.3} = .1038$ (.0574)
$r_{12.6} = .0879$ (.0574)
$r_{13} = -.1141$
$r_{13.6} = -.1618$ (−.1141)
$r_{13.2} = -.1293$ (−.1141)
$r_{13.26} = -.1996$ (−.1141)

$r_{04.1} = .5005$ (.4947)
$r_{14} = -.0182$
$r_{14.2} = -.0455$ (−.0182)
$r_{14.3} = -.0015$ (−.0182)
$r_{14.23} = -.0418$ (−.0182)

$r_{05.1} = .3862$ (.3499)
$r_{15} = .1366$
$r_{15.2} = .1250$ (.1366)
$r_{15.3} = .1753$ (.1366)

$r_{16} = .1669$
$r_{16.0} = .1557$ (.1669)

$r_{23.1} = .2169$ (.2086)
$r_{45.23} = .1534$ (.1366)
$r_{25.3} = .2764$ (.3169)
$r_{24.3} = .3842$ (.4062)
$r_{23.6} = .2672$ (.2086)

$R_{0.12} = .5707$
$R_{0.13} = .3675$
$R_{0.23} = .5748$
$R_{0.123} = .6058$
$R_{6.01} = .2182$
$R_{0.45} = .5209$
$R_{0.245} = .6179$
$R_{0.1245} = .6570$
$R_{0.12345} = .6740$
$R_{0.123456} = .6741$
$R_{0.456} = .5213$

BIBLIOGRAPHY

1. McCloy, C. H., *Appraising Physical Status: The Selection of Measurements.* (Iowa City, Iowa: State U. of Iowa, 1936).

2. Franzen, Raymond, *Physical Measures of Growth and Nutrition.* (New York: American Child Health Association, 1929).

3. Rogers, F. R., *Physical Capacity Tests.* (New York: A. S. Barnes and Co., 1931).

4. McCloy, C. H., "Norms of Tests for Strength." (Published in mimeographed form, U. of Iowa, 1933).

5. Martin, E. F., "Tests of Muscular Efficiency." *Physiol. Rev.* (July 1921).

6. McCloy, C. H., "The Measurement of General Motor Capacity." (published in mimeographed form, U. of Iowa, 1933).

7. Turner, C. E., *Personal and Community Hygiene.* (St. Louis: C. V. Mosby Co., 1935).

8. Editorial, "Intercollegiate Sports for Women," *American Physical Education Review* (April 1924) 198.

9. Williams, J. F., *The Principles of Physical Education.* (Philadelphia: W. B. Saunders Co., 1928).

10. Williams, Dambach, and Schwendener, *Methods in Physical Education.* (Philadelphia: W. B. Saunders Co., 1932).

11. Rogers, F. R., *Fundamental Administrative Measures in Physical Education.* (Newton, Mass.: The Pleiades Co., 1932).

12. Smiley and Gould, *College Textbook of Hygiene,* (New York: The Macmillan Co., 1931).

13. Sharman, Jackson, *The Teaching of Physical Education,* (New York: A. S. Barnes and Co., 1936).

14. Wayman, Agnes R., *Education Through Physical Education,* (Philadelphia: Lea and Febiger, 1934).

15. McCurdy, J. H., *The Physiology of Exercise,* (Philadelphia: Lea and Febiger, 1928).

16. Wood and Brownell, *Source Book in Health and Physical Education,* (New York: The Macmillan Co., 1925).

A Study of the Behavior of Boy Campers

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PURPOSE

THE purpose of this study is to discover the types of behavior, and the frequency thereof, that result from a tabulation of the daily reports of the Camp Frisbie leaders, for the Summer of 1937.

SOURCE OF DATA

The daily reports summarized herein were filled out by a leader, or a committee of leaders at Camp Frisbie during the summer of 1937. This camp is owned and operated by the Episcopal Church of the State of Michigan for boys from seven to twelve years of age. It accommodates seventy-five children and is staffed by a crew of twenty-eight, fifteen of whom come into direct contact with the campers as a part of their duty and thus are responsible for the evening reports.

The camp served 215 boys over the whole summer. Each boy's stay varied from one to eight weeks. The campers came from middle-class, church-going families which helped to minimize the behavior difficulties that would be due to a low social-economic status.

The leaders ranged from sixteen to twenty-three years of age. One-third of the fifteen have had at least one year of experience as a leader in some camp. All the counselors had been to camps when they were younger. None of them had had any course in camp leadership. The camp counselor training of the group was limited to a series of seven two-hour lectures by the director and an all-summer series of fifteen minute early morning discussions. A list of suggestive items to which the leaders might refer for inspiration in the writing of their daily anecdotes and comments was posted in the counselor's club rooms.

The daily reports were written by each leader directly following taps. The comments made contained any information about the camper, or any thinking thereon that the leader deemed worth reporting.

PROCEDURE

In the tabulation of the leader comments it was arbitrarily decided whether or not the behavior described in the remark favored the fullest functioning of the child's abilities and talents. Some of the state-

ments are in the child's favor and some of the items are unfavorable criticisms. If the comment was unfavorable it was included in a tabulation that describes behavior detrimental to the child. If the item was complimentary it was included in a tabulation of remarks descriptive of actions that are beneficial in one's daily living. Those statements that are neutral, such as "O.K.," "same kid," "nothing new," etc., are omitted in the tabulation.

The tabulations were made in three different camper groupings: first, a tabulation of all the remarks made in the evening reports over the whole summer and for all the boys who attended camp; second, a tabulation of the comments made about the campers who stayed from six to eight weeks; and third, a tabulation of the comments made about the one- to five-week campers.

DISCUSSION

Table I shows the tabulation of the favorable remarks for the entire camp arranged in order of frequency.

TABLE I

FAVORABLE COMMENTS ABOUT CAMPERS—ENTIRE GROUP

Comments	Total Frequency
1. A fine boy or camper, (general statement)	313
2. Cooperates readily, willing to help	202
3. Enjoying self, cheerful, happy	147
4. Improving (general statement)	112
5. Confident, mixing well, becoming more poised	104
6. Constructively aggressive for self-improvement, active	92
7. Likable, well liked, accepted by group	92
8. Is leader or is assuming leadership in group	67
9. Obedient, minds well	58
10. Thoughtful of, and kind to others	53
11. Has ability or is improving in ability in camp skills	50
12. Has good etiquette, or etiquette is improving	49
13. Alert, mentally interested in things	45
14. Robust, health good. Fine physical specimen	40
15. A good influence	13
16. Neat, tidy	5
Total number of comments	1442

The most frequently made favorable criticism, and perhaps the most easily made, is the one that heads the list in Table I, namely, that the boy is fine, is a good camper, and is a comfort to the harassed leader's existence. The second most frequently complimentary comment concerns the boy's willingness to cooperate with the leader and with others when there is work to be done around the cabin.[1]

[1] It is interesting to note that the detailed tabulation by cabins showed that the cabin manned by one of the poorest leaders in camp made seventy remarks about the willingness of the boys to help. None of the other cabins had more than 27 remarks on this topic.

The third most frequent favorable item describes the camper's fun that day, or his cheerfulness, or his outspoken enjoyment of camp life. Often the leader merely noted the one word "improving," making it the fourth most frequent notation. Other frequently mentioned remarks that are favorable to the boy's personality are: "becoming more poised"; "constructively using time"; "likable, well liked, accepted by the group"; "minds well, is obedient, does what he is told to do."

Table II shows a tabulation of the unfavorable comments arranged in order of frequency.

TABLE II

UNFAVORABLE COMMENTS ABOUT CAMPERS—ENTIRE GROUP

Comments	Total Frequency
1. Shows off, attracts attention, acts superior	223
2. Poor mixer, withdrawn, shy, retiring	169
3. Teasing, quarreling, grouchy, disturbs others	139
4. Spoiled, overdependent, super-sensitive, babyish	119
5. Flaunts rules, disobedient, minds poorly	111
6. Unwilling to help, lack of cooperation	111
7. Indifferent, lack of interest in activities	75
8. Nervous habits, excitable, unstable	71
9. Goat of cabin, not accepted, losing favor	69
10. Very slow	66
11. Verbally insolent and sarcastic	65
12. Homesick	59
13. Weak, lacks robustness, ill	52
14. Lacks tidiness, is messy	43
15. Etiquette poor	41
16. Does not take care of property, careless	33
17. Obscenity	31
18. Giddy, silly behavior	31
19. A bad influence	25
20. Marked overactivity, wasted energy	23
21. Enuresis	23
22. Display of temper	22
23. Not responsible, unreliable, undependable	22
24. Lying	16
25. Apparent inferiority feelings	14
Total number of comments	1639

Table II is led by the comment about the boy's tendency to attract attention, act superior, and be noisy, all of them totaling to the situation that the child is an excessive recognition seeker. The second most frequent comment on the negative side of the ledger concerns the retiring actions and the way that the camper avoids others. The third discusses the tendency of the camper to be a source of irritation to others with his teasing, quarreling, or grouchiness. The fourth describes the babyishness of the camper including his dependency and spoiled child behavior. The fact that the child minds poorly and is disobedient comes in for the fifth greatest number of remarks. The three remarks made least often were, in order of infrequency; apparent inferiority feelings, lying, not reliable.

In the detailed, by-cabin tabulations there is no indication that behavior problems increased in number according to increase in age.[2] In fact, just the opposite occurred in these findings. The two youngest groups had many more unfavorable remarks made about them per capita, and per cabin, than the cabins which contained the oldest boys in camp, although the latter were next highest in frequency of unfavorable observations.

Over the whole summer, and in considering the entire camp attendance, there were more unfavorable remarks than favorable ones in the ratio of 1,639 to 1,442. One would expect such a situation since the reports are intended to make a record for the leader of all the personality quirks that need straightening and are also to serve as a source of information for the director so that he may have some knowledge of the daily adjustment of the boys in camp. Thus, it is likely that the leader would feel that uncomplimentary comments are more urgent and more worth noting than the favorable comments. The unfavorable comments are much more specific—that is, exactly descriptive of specific behavior—than are the favorable statements, which are usually vague generalizations about the qualities that the boy possesses.

THE BEHAVIOR OF THE SIX- TO EIGHT-WEEK CAMPERS

The tables for the whole camp were broken down into a tabulation of statements made concerning the campers who stayed from six to eight weeks, 23 in number; and a table containing the comments made about the campers who stayed for periods ranging from one to five weeks, totaling 192.

This separation was made because it was thought that the prevalence of boys who were in camp for a small number of weeks, and the difficulties of adjustment that such short-period campers have, caused the unfavorable comment table to be unduly weighted in some areas. It was thought necessary, therefore, to make a separate tabulation of the six- to eight-week campers who were in camp long enough to become more surely adjusted, and to compare this group with a group which attended camp for a shorter period of time, the one- to five-week boys.

Table III shows the result of the tabulation of favorable remarks for the six- to eight-week campers.

The ranking of these items is not much different than the favorable comments made about the whole camp. The rankings of the tabulation areas describing the improvement, the likableness and the leadership

[2] W. E. McClure, "Characteristics of Problem Children Based on the Judgment of Teachers," *Journal Juv. Research*, 1929.
L. Ackerson, *Children's Behavior Problems*, University of Chicago Press, 1930.
Both of these writers claim that problems increase in frequency with age up to the years of 10 to 13, when there is a decrease.

TABLE III

FAVORABLE COMMENTS ABOUT CAMPERS—SIX-TO-EIGHT-WEEK CAMPERS

Comments	Total Frequency
1. Fine boy or camper (general statement)	116
2. Improving (general statement)	74
3. Cooperates readily, willing to help	41
4. Likable, well liked, accepted by group	34
5. Leader or assuming leadership in group	28
6. Confident, mixing better, becoming poised	26
7. Constructively active	24
8. Ability, and improvement in ability in camp skills	19
9. Enjoying self, cheerful, happy	13
10. Minds well, obedient	13
11. Thoughtful of, and kind to others	11
12. Good etiquette, or etiquette improving	11
13. Alert, mentally interested in many things	3
14. Robust, health good, fine physical specimen	2
15. A good influence	2
16. Neat, tidy	0
Total number comments	417

of the boy are higher in this table than in the table for the whole camp. The counselor's most frequent observation in the boy's favor falls again in the area of the general statements about the boy's fineness and his ability as a camper. The second most frequently mentioned item on this table concerns the fact that the boy is improving in some respect; third, the camper cooperates readily, is willing to help; fourth, the boy's likableness; fifth, his leadership.

Table IV shows the results of a tabulation of the comments that are unfavorable to the six- to eight-week campers.

The reader may note the ranking of various items by inspection of the table. This table shows that the comments concerning the camper's withdrawn traits, his excitableness, and his insolence are all much lower in ranking in this six- to eight-week tabulation than they are in the tabulation for the whole camp. The three most infrequently made comments about this veteran group in order of infrequency are messiness, temper displays, and lack of interest. Each of these areas ranks much higher in the tables for the entire camp group.

The total number of favorable remarks made about the six- to eight-week campers is more—nearly one-fifth—than the total number of unfavorable remarks made about the same group. It will be recalled that the total camp situation was exactly the reverse of this in that there were more unfavorable comments than favorable ones.

A tally was made of the date of each of the remarks made about this six- to eight-week group as well as for the area in which it fell. There is not sufficient space to show the details of these findings; however, it is apparent that more and more favorable remarks were made about these boys as the summer wore on. Such a situation may be due

TABLE IV

UNFAVORABLE COMMENTS ABOUT CAMPERS—SIX- TO EIGHT-WEEK CAMPERS

Comments	Total Frequency
1. Shows off, attracts attention, acts superior, boasts, noisy	57
2. Disturbing to others, teasing, grouchy, quarrelsome	43
3. Spoiled, over-dependent, babyish, sensitive	41
4. Flaunts rules, disobedient, minds poorly	24
5. Very slow	23
6. Lack of cooperation, unwilling to help	23
7. Lacks tidiness—is messy	16
8. Goat of cabin, losing favor, disliked by boys	13
9. Weak, lacks robustness, ill	11
10. Poor mixer, withdrawn, avoids others	11
11. Lack of interest, indifferent	11
12. Homesickness	10
13. Giddy silly behavior	8
14. Nervous, unstable, excitable, tense	8
15. Does not take care of property, careless	7
16. Obscenity	6
17. Poor etiquette	6
18. Displays of temper	5
19. Enuresis	4
20. Bad influence	2
21. Not responsible, unreliable, undependable	2
22. Marked over-activity	2
23. Lying	2
24. Apparent inferiority feelings	1
25. Sarcastic, verbally insolent	0
Total number of comments	336

to the fact that the leader gets to know the boy better as the season passes and therefore either learns to tolerate his behavior quirks, or has succeeded in better adjusting the boy, or else so much admires the boy that he finds it difficult to make deprecatory remarks about him. Probably too, this long period group of campers had a greater chance to reflect the counselor's natural and optimistic hope that his boys are getting along well.

THE BEHAVIOR OF THE ONE- TO FIVE-WEEK CAMPERS

As mentioned above, a separate study of the one- to five-week campers, totaling 192 and having a high preponderance of short-staying boys, was made in order to see what ranking the tabulation areas would take with this group.

Table V shows the ranking of the favorable remarks made concerning the one- to five-week campers.

Since this group is so large the comments made about it fall into much the same ranking as those made about the entire camp attendance. The most interesting result of a comparison between the whole camp and one- to five-week group is that the frequency of remarks concerning leadership and ability in camp skills drop to a much lower ranking in the latter.

Table VI shows a tabulation of the unfavorable remarks made about the one- to five-week period campers.

This table is quite similar to the unfavorable remarks table for the total group, since it includes such a large proportion of the camp attendance. Table VI describes the behavior of a large number of boys

TABLE V

FAVORABLE COMMENTS ABOUT CAMPERS—ONE- TO FIVE-WEEK CAMPERS

Comments	Total Frequency
1. A fine boy or camper (general statement)	197
2. Willing to help, cooperates readily	161
3. Enjoying self, cheerful, happy	134
4. Becoming more poised, confident, mixing better	78
5. Constructively aggressive	69
6. Likable, well liked, accepted by the group	58
7. Minds well, obedient	45
8. Alert, mentally interested in many things	42
9. Thoughtful of, and kind to others	42
10. Leader, or is assuming leadership in the group	41
11. Improving, general statement	39
12. Robust, in good health, fine physical specimen	38
13. Etiquette good or is improving	38
14. Ability or improvement in ability in skills	32
15. A good influence	11
16. Neat, tidy	5
Total number of comments	1030

TABLE VI

UNFAVORABLE COMMENTS ABOUT CAMPERS—ONE- TO FIVE-WEEK CAMPERS

Comments	Total Frequency
1. Poor mixer, withdrawn quiet, retired, shy	158
2. Show off, attracts attention, boasts, noisy	158
3. Disturbs others, teasing, grouchy, quarrels	96
4. Lack of cooperation, unwilling to help	88
5. Disobedient, minds poorly, flaunts rules	87
6. Spoiled, overdependent, babyish, sensitive	79
7. Verbally insolent and sarcastic	66
8. Lack of interest, indifferent to activities	64
9. Nervous habits, excitable, unstable	63
10. Goat of cabin, losing favor, unpopular	49
11. Homesick	48
12. Weak, lacks robustness	42
13. Very slow	38
14. Poor etiquette	35
15. Does not take care of property, careless	27
16. Lacks tidiness, is messy	27
17. Obscenity	24
18. Giddy silly behavior	23
19. A bad influence	23
20. Marked overactivity	21
21. Not responsible, unreliable	20
22. Enuresis	20
23. Displays of temper	17
24. Lying	14
25. Apparent inferiority feelings	13
Total number of comments	1300

who do not stay in camp long enough to come to the point of feeling confident of themselves or the camp atmosphere. This group has more of this type of remark made about it that describes behavior typical of the withdrawn, quiet, poor mixing, avoiding others sort of a child than any other area of remarks, except for the old standby about a boy's tendency to be a show-off, to act superior, or to be noisy, which has an equal number of comments.

The total number of unfavorable remarks for the one- to five-week campers is far in excess of the total number of favorable remarks. This is to be expected since the boys included in the table have a strong proportion of campers who were not with us long enough to straighten them out, or for the leader to get past the point of inventorying the disliked behavior of his newly acquired charges.

SUMMARY

1. A tabulation of the evening reports made by the leaders at Camp Frisbie was divided into favorable and unfavorable comments. Separate tabulations under these headings were made for the entire camp group, for the boys who stayed at camp for a period of from one to five weeks, and for the boys who attended camp for a period of from six to eight weeks.

2. The entire camp group had these favorable comments made about it in this order: fine camper, cooperates willingly, enjoys camp life, improving, becoming more poised.

3. These unfavorable comments were made about the whole group in order: attention attracter, withdrawn, grouch, overdependent, disobedient.

4. There was a larger total of unfavorable observations than complimentary comments in describing the entire camp group.

5. A counselor is more likely to be specific when describing unfavorable traits than when describing favorable ones.

6. The remarks made about the boys who were in camp from six to eight weeks show that they were the best liked, more often displayed leadership, and showed more improvement than the rest of the camp.

7. The total of favorable comments exceeded the total of unfavorable comments for this group.

8. More of the favorable statements for the above group came toward the end of the summer than in the beginning weeks.

9. The one- to five-week campers had a greater number of comments describing withdrawn behavior than the camp as a whole, and were less frequently described as being able in leadership and camp skills.

10. The total of unfavorable remarks for the short-stay group is in excess of the favorable observations.

The Effect of Rule Changes Upon the Distance Traversed by Basketball Players

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IN AN attempt to determine the effects of the ten-second rule, and the rule eliminating the center jump, as regards the distance traveled by basketball players during a game of college basketball, the following data were obtained. This is the continuation of a similar project reported on in 1931, before the inclusion of the ten-second rule and the rule eliminating the center jump after scoring of field goals.[1]

The measurement was made possible through the development of an electrical pursuit apparatus which provides for numerical registration of unit distances traveled. The piece of apparatus consists of a tin base, on which is etched a basketball court laid off to scale, wired in series with a storage battery, an electric impulse counter, and a small brass tracing wheel, four inches in diameter. Strips of insulating tape are placed on the wheel at half-inch intervals so that rolling it along the floor makes and breaks a circuit each half inch. The impulse counter records these contacts, each one of which, with the calibration employed, indicates a distance of two feet on the 50 by 94 foot playing floor. To determine the number of feet traveled by a player, the experimenter follows the movements of the player on the small floor with the tracing wheel. Rolling the wheel from one end of the small floor to the other produces a total of 47 contacts, which multiplied by 2 gives 94, (the length of the floor in feet) so any inaccuracy in the result lies in the inability of the operator to follow accurately the movements of the player. All observations were made from the balcony above the floor where a clear and unobstructed view of the playing floor was available at all times. The apparatus used in the present study is identical with that used in the 1931 study so that the relative difference in distance traveled by players in the two experiments should

[1] L. L. Messersmith and M. S. Corey, "Distance Traversed by a Basketball Player," Research Quarterly, II (May, 1931.)

be reasonably accurate, even though slight inaccuracies might be present in recording the number of feet traversed by a player in any one game.

In the 1931 study it was found that distances traveled by players ranged from 2.25 miles to 2.50 miles per game. In the present study, however, the distances traveled have been consistently longer, ranging from 3.87 to 3.97 miles per game. Complete records have been kept of several games, but only three representative games are included in Table I.

TABLE I

Number of Feet Traversed on Offense and Defense							Game Totals		Ball Changes During Game		
Game No.	Offense First Half	Offense Second Half	Defense First Half	Defense Second Half	Total Defensive	Total Offensive	In Feet	In Miles	First Half	Second Half	Total For Both
1*	4778	3910	4760	6988	11748	8688	20436	3.87	33	26	59
2	4970	4754	5680	5570	11250	9724	20974	3.97	34	40	74
3	5632	6507	3824	4974	8798	12139	20937	3.96	32	30	62

* In game 1, a player in the guard position was clocked; in game 2 the center; and in game 3 a forward.

Since a study was not made of distances traversed following the inclusion of the ten-second rule, and before the inclusion of the rule eliminating the center jump, it is impossible to state the relative effects of these two rules upon the increase in distance traversed by players in college basketball games. Both have undoubtedly been contributing factors, but to say which has had the greater influence would be, in the opinion of the writers, a mere guess. Both studies were made on players representing the DePauw University basketball team, which team was under the direction of the same coach during the course of both studies. In general, changes in styles of play which would affect the distance traveled by a player have been only those which were necessitated, or made possible, through the application of the rules under consideration.

SUMMARY

1. Distances traveled by players in college basketball games are consistently greater than they were in 1931, before the inclusion of the ten-second rule and the rule eliminating the center jump after scoring of field goals.

2. It is not possible to draw definite conclusions, from this study, regarding the relative effects of the two rules upon the increase in distance, as no study was made following the inclusion of the ten-second rule.

3. Distances were found to range from 3.87 miles to 3.97 miles per game in the present study, as against a range of 2.25 to 2.50 miles per game in 1931.

What People Do in Their Spare Time

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A NUMBER of studies have been made on the leisure-time activities of people in various localities in the United States. Since they were made by different individuals or organizations, the material covered is dissimilar and there is no general consistency in either approach to, or classification of activities. For this reason it is difficult to classify and rank the activities with any high degree of accuracy under specific headings. Seventeen such studies have been made.[1] For purposes of this study only those of adults will be considered.

One study, including only ages 16 to 24, is so comprehensive in scope and accurate in detail that it will be quoted separately from the group data. This study was made during the period March to August, 1935, by the Committee on Youth Problems of the United States Office of Education (5:54-56).* A representative cross section of youth of the ages of 16 to 24, in thirteen communities ranging in size from four thousand to more than a million in population, formed the basis of the study. Interviews were held with 48,801 boys and girls in order to find out not only what recreational activities those young people took part in, but those which they would like most to take part in, regardless of the activities in which they actually participated.

The listings in Table I show the various leisure-time pursuits ranked in the order of actual participation by these 48,801 boys and girls, and also as these young people desired to participate in them:

The group data on passive activities were compiled from eight of the previously mentioned studies. There is little comparable data showing the desire to participate in passive activities. This is perhaps due either to the fact that not enough people wanted to participate in passive pursuits, or that these studies were not included in the check lists of the investigators. The rank order for actual participation in passive activities is shown in Table II.

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[1] See items in Bibliography at end of article as follows: 1, 6, 3, 12, 20, 22, 19, 14, 16, 18, 2, 17, 21, 8, 13, 15, 5.

* Throughout the article, references have been simplified as follows: first number refers to the book or article of that number in the Bibliography at end of article; second number cites the pages of that item.

TABLE I

LEISURE-TIME PURSUITS OF 48,801 BOYS AND GIRLS

Actual Participation		*Desired Participation*	
Rank Order	Activity	Rank Order	Activity
	Boys		
1	Reading	1	Swimming
2	Baseball	2	Basketball
3	Swimming	3	Tennis
4	Other	4	Reading
5	Shows	5	Football
6	Tennis	6	Sports
7	None	7	Baseball
8	Football	8	Fishing
9	Dancing	9	Golf
10	Mechanical construction activities	10	Travel
		11	Dancing
12	Music	12	Shows
13	Basketball	13	Other
14	Sports	14	None indicated
	Girls		
1	Reading	1	Swimming
2	Swimming	2	Tennis
3	Shows	3	Reading
4	Dancing	4	Dancing
5	Other	5	Shows
6	Tennis	6	Sewing
7	Household activities	7	Sports
8	Sewing	8	Music
9	None	9	Travel
10	Walking and hiking	10	Riding horseback
11	Music	11	Golf
12	Parties and socials	12	Basketball
13	Radio	13	Other
14	Visiting	14	None indicated

TABLE II

PARTICIPATION IN PASSIVE PURSUITS (EIGHT STUDIES)[2]

1	Reading (Newspapers and magazines).	9	Writing letters.
2	Movies.	10	Clubs.
3	Books (fiction and non-fiction).	11	Cards (bridge, etc.).
4	Radio (listening).	12	Conversation.
5	Motoring.	13	Picnics.
6	Visiting and entertaining.	14	Theatre (concerts and shows).
7	Watching sports events (baseball, football, track and field).	15	Celebrations and parties.
		16	Amusement parks.
8	Music (singing or playing instruments).	17	Phonograph and player piano.

[2] 1:10, 8:25, 17:9, 2:1-2, 16:32, 20:268, 3:12, 6:12.

It was possible to find, in seventeen studies, data on actual participation in activities.[3] Only five of these studies gave any data on what activities were desired.[4] These data are contrasted in Table III.

TABLE III

RANK ORDER OF ACTIVITIES

Actual Participation in Activities (17 studies)		Desires for Active Pursuits (5 studies)	
1	Swimming	1	Swimming
2	Hiking	2	Tennis
3	Tennis	3	Horseback riding
4	Social dancing	4	Skating
5	Golf	5	Golf
6	Horseshoes	6	Camping
7	Bowling	7	Bowling
8	Fishing	8	Rowing and boating
9	Skating (ice or roller)	9	Walking and hiking
10	Camping	10	Social dancing
11	Handball	11	Fishing
12	Softball, baseball, and diamond ball	12	Hunting
13	Basketball	13	Volleyball
14	Rowing, boating, and canoeing	14	Basketball
15	Horseback riding	15	Croquet
16	Ping pong	16	Baseball
17	Rifle shooting and hunting	17	Apparatus, tumbling, and gymnastics
18	Volleyball	18	Bicycling
19	Croquet	19	Archery
20	Apparatus, tumbling, and gymnastics	20	Fencing

Mr. George Butler, under the auspices of the National Recreation Association, made a study of the leisure hours of five thousand people.[5] It is illuminating to compare a list of ten activities in rank order of increase in participation as against a list of activities in rank order most frequently checked by individuals who express a desire to take part in them. (Table IV).

From the studies just listed it is noticeable that people are engaging in passive pursuits within the home more frequently than before. Judging from their expressed desires it would seem that they prefer to engage in outdoor activities of a more strenuous nature. Presumably, people are not doing what they *desire* to do but rather are doing things they find it *possible* to do. Their needs and desires can be met only by better provision of facilities, equipment, and leadership supplied by public or private agencies. The fulfilling of these varied desires and needs becomes a function of the community, state, and federal governments.

[3] 8:25, 1:10, 13:81-82, 15:18, 8:25, 21:11, 18:51, 17:7, 2:1-2, 16:32, 14:77, 19:24, 22:215, 20:268, 12:89, 3:1-2, 6:1-2.

[4] 3:3-4, 8:25, 15:18, 13:83-84, 1:21-22.

[5] 1:2.

TABLE IV

Activities in Order of Net Increase in Actual Participation		Desired Activities	
Rank Order	*Activity*	*Rank Order*	*Activity*
1	Reading magazines and newspapers	1	Playing tennis
2	Listening to radio	2	Swimming
3	Reading books—non-fiction	3	Boating
4	Conversation	4	Playing golf
5	Caring for home grounds	5	Camping
6	Caring for flower garden	6	Caring for flower garden
7	Reading books—fiction	7	Playing musical instruments
8	Swimming	8	Automobile riding for pleasure
9	Visiting or entertaining others	9	Attending legitimate theater
10	Serious study	10	Ice skating

The forward looking general educator will take cognizance of these implications and instigate a wide program within the school itself. Meanwhile the present situation may be partially alleviated by provision, by the school, of leadership and facilities for the adult population.

BIBLIOGRAPHY

1. Butler, George D., *The Leisure Hours of 5,000 People.* (New York: National Recreation Association, 1934).

2. Cincinnati Schoolmaster's Club, *Leisure and the Schools.* (New York: National Recreation Association, March, 1935).

3. Gates, C. Ray, *Leisure Activities Survey of Grand Island, Nebraska, Adults.* Unpublished survey, October, 1936.

4. Huus, Randolph O., *Financing Municipal Recreation.* (Menasha, Wis.: George Banta Publishing Company).

5. Jessen, Carl A., and Hutchins, H. C., *Community Surveys.* Bulletin No. 18 of Youth Series of the Office of Education. (Washington, D.C.: U. S. Department of the Interior, 1936).

6. Mallison, N. L., *Hobbies of a Rotary Club.* Bulletin No. 3197. (New York: National Recreation Association, September, 1934).

7. Mitchell, Elmer D., and Mason, Bernard S., *The Theory of Play,* (New York: A. S. Barnes and Company, 1935).

8. Nelson, Janet F., *Leisure-Time Interests and Activities of Business Girls.* (New York: The Woman's Press, 1933).

9. Neumeyer, Martin H., and Neumeyer, Esther S., *Leisure and Recreation.* (New York: A. S. Barnes and Company, 1936).

10. Steiner, Jesse F., *Recent Social Trends in the United States.* Report of President Hoover's Research Committee. (New York: McGraw-Hill Book Company, 1933).

11. Steiner, Jesse F., *Americans at Play,* (One of a series of monographs on "Recent Social Trends in the U. S.") (New York: McGraw-Hill Book Company, 1933).

12. Bike, Edward L., *Contributions of College Intramural Activities to Post-College Recreational Activities of Williams College Graduates of the Classes of 1920, 1925, and 1930.* M. A. Thesis, School of Education, New York University (unpublished), 1931.

13. Bosworth, Frederick Lyman, *A Study of the Possible Carry-over from Physical Activities in School to Adult Life.* M.Ed. Thesis, School of Education, Boston University, 1934.

14. Bottje, Mary, *A Study of Secondary School Programs of Physical Education as Related to the Leisure-Time Activities of 875 College Women.* M. A. Thesis, University of Michigan, 1934.

15. Goetter, B. S., *A Study of the Recreational Activities of Employed Women.* M. A. Thesis, University of Pittsburgh, 1927.

16. Hamblen, Malinda, *A Study of the Leisure-Time Activities of the Women Students of a Teachers College with Specific Reference to Activities Offered by W. A. A.* M. A. Thesis, New York University, 1930.

17. Hupp, Carrie A., *An Analysis of the Leisure-Time Activities of the Graduates of a State Teachers College.* M. A. Thesis, Colorado State Teachers College, 1934.

18. Saxman, J. E., *Students' Use in Leisure-Time of Activities Learned in Physical Education in State Teachers Colleges,* Ph.D. Dissertation, Teachers College, (Contributions to Education), Columbia University, 1926.

19. Wilder, Emma Lucy, *The Inadequacies of the Present Program of Physical Education Activities for Girls to Provide Recreational Interests for Leisure Time.* M.Ed. Thesis, Harvard University, 1934.

20. Flad, Marion, "Leisure-Time Activities of 400 Persons," *Sociology and Social Research,* 18 (January-February 1934) 265-74.

21. Guernsey, Paul D., "A Program of Physical Education and a Study of Its Carry-over Effects," *Journal of Health and Physical Education.* 4 (June 1933) 11.

22. Haynes, Wilma D., "After College What?" RESEARCH QUARTERLY (March 1931) 214-16.

23. National Recreation Association, "Recreation Yearbook of 1935," *Recreation,* 30 (June 1936) 97-184.

24. Tunis, John R., "Changing Trends in Sport," *Harper's Magazine,* (December, 1934) 75–97.

25. Works Progress Administration Information Service, "Increasing America's Recreation Facilities," *Recreation,* 30 (December 1936) 448-50.

BOOK REVIEWS

MODERN PRINCIPLES OF PHYSICAL EDUCATION. Jackson R. Sharman. (New York: A. S. Barnes and Company, 1937), 208 pages, $2.00.

It is unfortunate that so many teachers of physical education do not possess a thorough understanding of what they are trying to do and why they are doing it. It is a common observation to see teachers who are highly skilled in "floor" work or in coaching, but who have never stopped to think of the place of their work in the life of today. Many do not realize the effect of their work on the growth and development of the child. As a result we often find programs of physical education that are entirely unrelated to the child and to the life in which he finds himself. There is little doubt that a thorough knowledge and application of the principles and philosophy of physical education are essential to the successful teacher. Dr. Sharman in *Modern Principles of Physical Education* presents the biological, psychological, sociological, and educational implications of physical education in a very concise and interesting manner. The conciseness of the discussions will appeal to many who prefer their philosophy in "digest" form. The reviewer felt that many of the principles stated could have been elaborated, with considerable value resulting from a more profound description and analysis of the relationships indicated. It is apparent, however, that the author directed this volume to students majoring in physical education. It is hoped that *Modern Principles of Physical Education* will be read and studied by teachers and administrators in the field. The latter can learn much from these pages.

The chapter on "The Physical Education Curriculum" (Chapter VIII) is outstanding. With the current and widespread interest in curriculum revision, this particular phase of the book will be welcomed by the numerous committees in school systems throughout the country who are confronted with this specific and important task. Such committees could ensure a sound educational development of their curriculum making by following the excellent suggestions of Dr. Sharman. The functional philosophy that should underlie every curriculum is clearly presented with suggestions for the choice of objectives, how these objectives may be motivated and attained, criteria for use in the selection of curriculum content, etc.

The application of the principles of physical education is made to leadership, method, and administration in the later chapters of this book.

Modern Principles of Physical Education will undoubtedly receive recognition as one of the best contributions to the literature of the field.

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HEALTH AND PHYSICAL EDUCATION FOR SMALL SCHOOLS. Lois Pedersen Broady. (Lincoln, Nebraska: University of Nebraska Teachers College and the University Extension Division, 1937), 192 pages, $1.75.

Bewildered teachers, who teach physical education as a part of their instructional load although their training has been in an academic field, will find this book a real help. In fact, Mrs. Broady

addresses her book to them and also to "the administrative officers of small schools in an endeavor to demonstrate to them the feasibility of building an organization of health and physical education for their own schools."

The author's experience in a small school situation is evident in her interesting ideas and specific suggestions. The untrained teacher could use the text as her health and physical education encyclopedia since Mrs. Broady outlines a worth-while program, discusses facilities and equipment, considers class organization, presents plausible course content, and lists games suitable for playground use.

The suggested program includes health work, class periods in physical education, supervision of the playground, intramural activities, and supervision of allied club activities. Under the groupings of rhythmic work, games, gymnastics, marching, tumbling, general posture work, and development of motor skills, Mrs. Broady summarizes the subject matter suitable for physical education classes.

The author believes in intramural participation rather than interschool competition and discusses appropriate activities. With the cooperation of superintendent and teacher in charge of boys' activities, coeducational physical education is also possible.

The book includes a number of references to literature which would be helpful in teaching health, rhythm, tumbling, sports, and games. Sample health record cards, plays, publicity letters, playday outlines, and athletic association programs and constitution could be used as models.

An experienced teacher will be interested in the way in which material has been adapted to the small school situation and in the helpful suggestions, and the untrained teacher will find the book a convenient and worth-while guide.

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THE ATHLETIC PLANT—LAYOUT, EQUIPMENT, AND CARE. Emil Lamar. (New York: Whittlesey House, McGraw-Hill, 1938), 302 pages. $3.00

The past few years seem to have marked the completion of several important cycles in our work. The strength work of Sargent returns with different adaptation and usage. The safety measures of Possé return as a part of the work in safety education. There is a renewed interest in anthropometry. There is a return to recognition of the place of the stunt apparatus.

The Athletic Plant, by Emil Lamar, is part of another revived interest. Not too many years ago no professional curriculum was complete without its course in "Construction and Equipment." The course gradually fell away under the pressure of credit hour totals and became an incidental part of the general course in administration. Recent texts in administration have shown a greatly increased attention to this phase of work, and, together with the architectural magazines, advertising manuals, and other periodicals, constitute a considerable body of literature. *The Athletic Plant* is directed at the layout, equipment, and care of the facilities for each sport, rather than embodying the usual "questions for embarrassing the architect" approach. It attempts to show how athletic equipment may be made in the school shop for the cost of materials only. In the preface the author states that "the aim has been to work out drawings as suggestions for others."

The book is directed almost altogether to the outdoor facilities. The playing fields are considered as regards their grading, surfacing, drainage, marking, and upkeep. The football coach who finds himself with insufficient funds for new equipment will find complete construction sketches offered for a tackling dummy machine, goal posts, and charging sleds. The basketball coach who wishes to construct outdoor basketball backstops will find excellent suggestions. Sketches are included for goals

for soccer and field hockey, and goals and banks for the ice hockey rink. Working plans for a movable batting cage constitute the chief contribution to baseball. One chapter is given to "Ideas and Suggestions for Bleacher Construction," with the problem considered as a project for high school shop students.

Track and field is covered in considerable detail with attention to the track itself in its layout and construction, and all pits, standards, and such equipment as hurdles, take-off boards, and toe boards. Performance indicators for high jump, broad jump, and pole vault are also included.

The construction of outdoor handball courts is considered, as is the problem of softball and baseball backstops and fields. Considerable attention is given to the tennis court. Some consideration is also given to the fencing of the fields.

A chapter on leisure-time activities, with the rather surprising inclusion of lacrosse and boxing, gives detail on the horseshoe pitching court, archery tackle and range equipment, and complete plans for table tennis tables and rackets. The badminton layout is also included here as is the construction of tetherball standards.

The trend toward evening use of facilities is recognized in the chapter "Night Lighting for Play Areas." The illustrations of typical installations, although representing the work of only one concern, may offer suggestive helps to many. A similar treatment is given to the problem of public address installations for the field.

An interesting chapter is given to the construction of scoreboards and field markers with samples for all of the common sports included. Illustrations are given of the combination of scoreboard and field equipment storage house. The book closes with a chapter entitled "Modern Efficiency in Handling Athletic Contests," which contains many administrative suggestions. Other suggestions are made in the chapter "Upkeep and Care of Athletic Equipment."

The book has little to offer to the experienced administrator with adequate library available. However, for the teacher in the typical "one-man job," who has but limited time for searching out materials and who has only a limited library, the book should prove decidedly valuable. To the coach or principal in the school where expense is the first consideration, it offers a practical way of meeting a problem. To the part-time coach with limited professional background it offers a ready source of much valuable material. It will also prove of worth to the beginning teacher and to the student in training.

Mr. Lamar has made a distinct contribution in giving us a book which allows the use of cooperative projects between the manual arts departments and the department of physical education to achieve a better program for all students in the school.

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PRIMITIVE AND PIONEER SPORTS. Bernard S. Mason. (New York: A. S. Barnes and Company, 1937), 342 pages, $2.50.

Recreational workers, group leaders, teachers, parents, camp counselors, and many others will find this splendid treatise on primitive and pioneer sports to be just the book for which they have been looking. Who hasn't yearned to throw the boomerang, the lariat, or crack a whip! These and many other sports of a similar nature are simply and completely described as to methods of use and construction. The author has had a wealth of experience and is sensitive to the yearnings of youth and adults. Most of the activities have a carry-over value into adulthood.

Here is a book which should find extensive use in the entire recreational field. Parents (especially Dad) will find material to keep father and son busy for many days. Most of the projects

can be pursued in the small space of one's back yard. Scouts, cubs, campers, and small play groups will find thrilling hours of activity through such sports.

That there is a great need of expression through such activities as described by Dr. Mason will be recognized by most educators. Many of the sports provide opportunity for the individual to be creative, and most of the equipment can be made. Many other values could be mentioned but the fact that the activities appeal to the imagination of all ages should in itself be sufficient recommendation. We sincerely hope that this volume is the beginning of a series of books on this much needed phase of activities.

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TESTS AND MEASUREMENTS IN PHYSICAL EDUCATION. Dr. J. F. Bovard and Dr. F. W. Cozens. (2nd. edition; Philadelphia: W. B. Saunders and Company, 1938) 427 pages, $3.00.

The second edition of this valuable book has been extensively revised to bring it up to date. Additions have been made to a number of the chapters and ohers have been radically revised.

Since 1930 there has been an increased amount of testing in the various phases of physical education, health education, and recreation. These authors have attempted to include all of the available sources and suggestions for tests and testing procedures in these fields.

The new test is divided into three parts: The Status of Measurement, The Tools of Measurement, and The Theory and Practice of Test Administration. In Part One, the need for and use of tests and the basic educational philosophy of the testing movement has been clearly described. Typical contributions in these fields are recorded: anthropometric measurements, strength tests, cardiac functional tests, athletic ability and achievement tests for all levels, sports tests, knowledge and information tests. It is becoming more apparent that physical education and health education must adopt measures to coincide with the academic procedures. The trend toward this will be noticed in the increased emphasis and experimentation in this particular field.

Part Two, dealing with tools of measurement, is a revised edition of the earlier book and includes practically all of the same material for statistical and experimental use of scores, grades, norms, and other records.

Part Three, the theory and practice of test administration, covers the criteria for selecting tests, proper and adequate methods of test instruction, and the techniques of administration.

Throughout the entire book numerous sources and references to material in all of the tests are given. Most of the tests are abstracted, so that each may be used for further research in various localities according to the needs of the individual situation.

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PLAY AND MENTAL HEALTH; PRINCIPLES AND PRACTICE FOR TEACHERS. John Eisele Davis. (New York: A. S. Barnes and Co., 1938) 202 pp., $2.50.

Many books on play and on mental health are written by theorists. This book has grown out of the experiences of an author who has direct practical contacts with the problems of play in relation to youth.

The author effectively meets the purpose of the book as set forth in the introduction where he states that he is discussing play as an effective basis for the organization of mental hygiene practices looking toward the development of a psychology of play in keeping with recent developments in child education. Emphasis throughout the book is placed on play as a means of self-expression and as an aid in socialization. The author sees in play the means of development of the timid child as well as furnishing an outlet for the self-

assertive tendencies. The outlining of play stages in child development is suggestive. To the author, play represents a valuable means in aiding the child to grow into reality as well as a means of reclaiming those who are losing or who have lost contacts with reality.

In four well organized chapters the problems of play are discussed in relation to (1) the psychic development, (2) outside adjustment, (3) behavior, and (4) the development of happy socialization. References to opinions of known authorities plus numerous illustrations from the author's experience add authority and interest to the book. The final pages summarize in concise form some of the hygienic objectives in play education. An annotated bibliography at the end of each chapter adds to the value of the book in suggesting outstanding discussions of play and mental health.

This book should prove to be very valuable to instructors in elementary and secondary schools and colleges in helping them to use play activities as an aid in understanding better and in meeting more effectively the mental health problems of youth. The book is not intended to outline principles of play but rather to make play principles more intelligible aids in the development of mental health.

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EMOTION AND THE EDUCATIVE PROCESS. Daniel A. Prescott. (Washington, D.C.: American Council on Education, 1938) 293 pages, $1.50.

This is the first section of a report on the relation of emotion to the educative process. It is a survey of the field with formulation of plans for further research. The second section is a report on progress already made in the development of measuring devices, and is to be published later under the direction of Professor Frederick H. Lund. This book raises and defines problems and experiments which might be done in this field.

The committee made an attempt to ascertain conclusions on whether:

1. Whether emotion has been unduly ignored in the educative process.
2. Whether emotion developed or inhibited by the educative process should be a concern of education.
3. Whether too much stress has been laid on the desirability of the scientific approach for youth in education.
4. The appropriate manner of approach in the event that the development and direction of emotion should be of more direct concern to education.

The terms "affective experience" or "affective factors" have been used to include the feelings, emotions, and emotional attitudes. Considering the importance of these phenomena in the assimilation of meaningful experiences, the committee feels that education should concern itself more directly with their strength and direction in relation to the educative process.

The part education is to play in the development of affective maturity is: (1) that of re-educating where behavior patterns do not fall within the accepted range for the needs of the individual and the society in which he lives, (2) to provide all children with experience conducive to the formation of acceptable patterns, and (3) the development of a mature value sense with the opportunity for active practice and the development of skill in continuously re-evaluating his experiences.

The committee considers its conclusions tentative and a stimulus to further research that will "validate or disprove current trends in thought about character development."

Many problems are suggested as suitable for research in the fields of physiological psychology, child development, and curricular, personnel, and administrative problems in education.

This book focuses attention on the large area open for exploration in the relationship of the emotions to education.

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EMOTIONAL HYGIENE: THE ART OF UNDERSTANDING. Camilla M. Anderson, M.D. (Philadelphia: J. B. Lippincott and Co.), $2.00.

Emotional maladjustments are the commonest of human illnesses. *Emotional Hygiene* meets the situation by endeavoring to establish a balance between life's realities on one hand and our inner urges and drives on the other.

Whence come these inner urges and drives? Unfortunately, we may not separate any individual from his environment, from his past experiences, or from his heredity. Indeed, his reactions are a composite picture of his physical and emotional health, acting and interacting on one another, as expressed in his very self. But whatever the complex of factors involved in an individual, the problem of happier living in the adult is connected with his ability to adjust and readjust to the changing factors of his environment. Furthermore, we must conceive of man as one, for if there cannot be mind over matter, there cannot be matter over mind. Verily, the spirit of emotional hygiene is caught, rather than taught!

We find this book to have a pleasurably readable and very human text superimposed upon a fundamental yet modern treatment of the subject matter. A discussion of basic and secondary emotional patterns pictures for us first, the intra-uterine felicity of the unborn child, with no adjustments to make, through the extra-uterine "hardships" by which the evolution of the personality is guided for better or for worse. These may range all the way from improper parent child attitudes, or a defective balance of the endocrine glands to what education considers to be the best type of environment.

There follow chapters on the adjustment of the personality in personal problems, to relatives, colleagues, patients—the book was written primarily for the nursing profession—the environment in general, all illuminated by accounts of specific situations to which the principles of emotional hygiene, as set forth, may well apply. The third unit of the book is concerned with the emotions in relation to specific fields of the nursing profession such as psychiatry, public health, public schools, and the nurse in the legal capacity of a witness. This particular emphasis, however, should not make the book less interesting and valuable to the thoughtful and intelligent parent, to the teacher, social worker, and clergyman.

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